Iron and Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

AUGUST, 1953

TECHNOLOGY DEPT.

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MESTA

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DETROIT

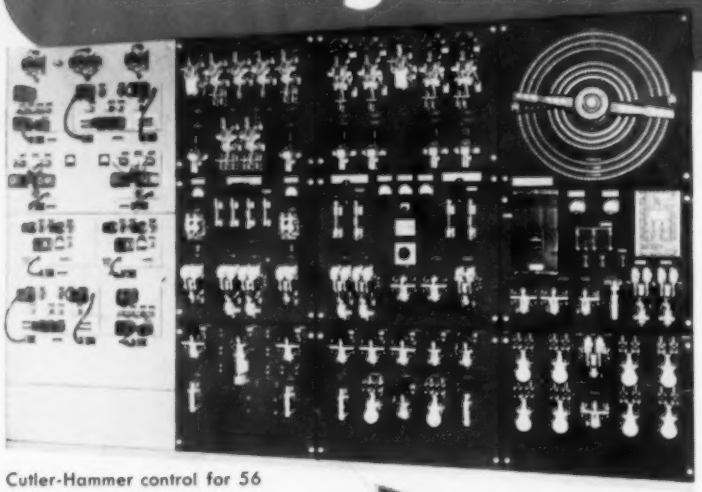
Mesta 56" Four-High Temper Mill

higher speed COLD MILLS

DESIGNERS AND BUILDERS OF COMPLETE STEEL PLANTS

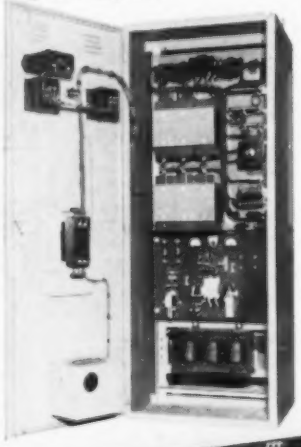
MESTA MACHINE COMPANY • PITTSBURGH, PA.

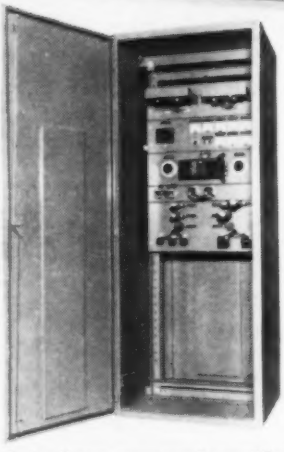
Nothing succeeds like success!



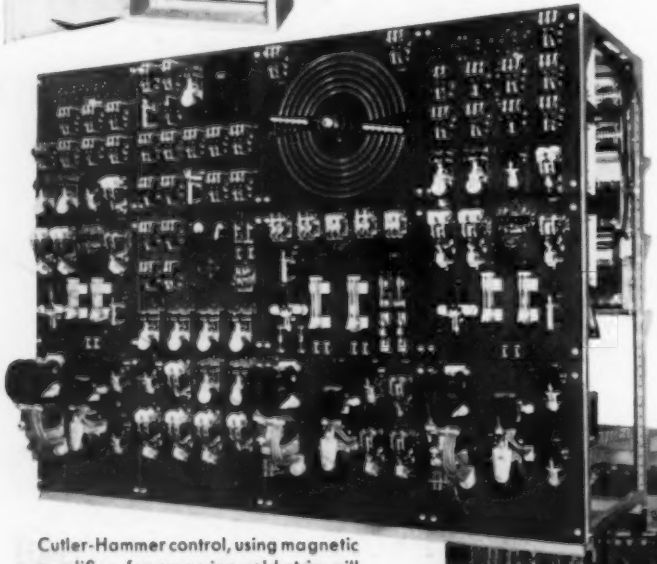
Cutler-Hammer control for 56 inch side trimming and shear line using magnetic amplifier.

Cutler-Hammer high frequency control for electric welding tube mill, using magnetic amplifier.

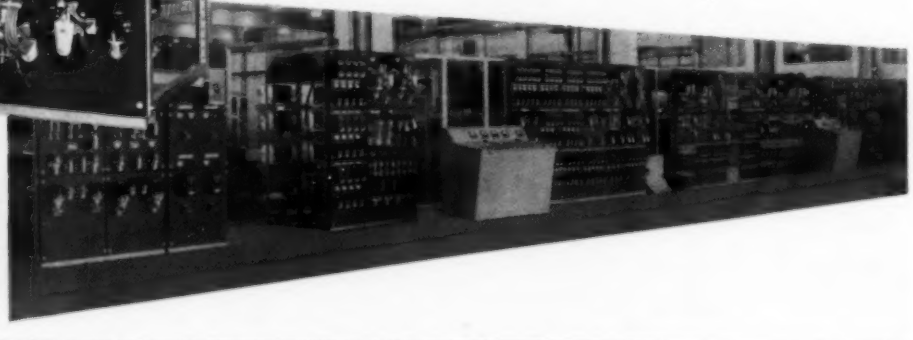




Cutler-Hammer magnetic amplifier speed regulator for a large tube mill.



Cutler-Hammer control, using magnetic amplifier, for reversing cold strip mill with tension and voltage regulation.



Cutler-Hammer D-C Controllers using magnetic amplifier for pipe mill in a southwestern steel mill.

Cutler-Hammer's experience in applying the Magnetic Amplifier to steel mill control assures correct solution of your problems.

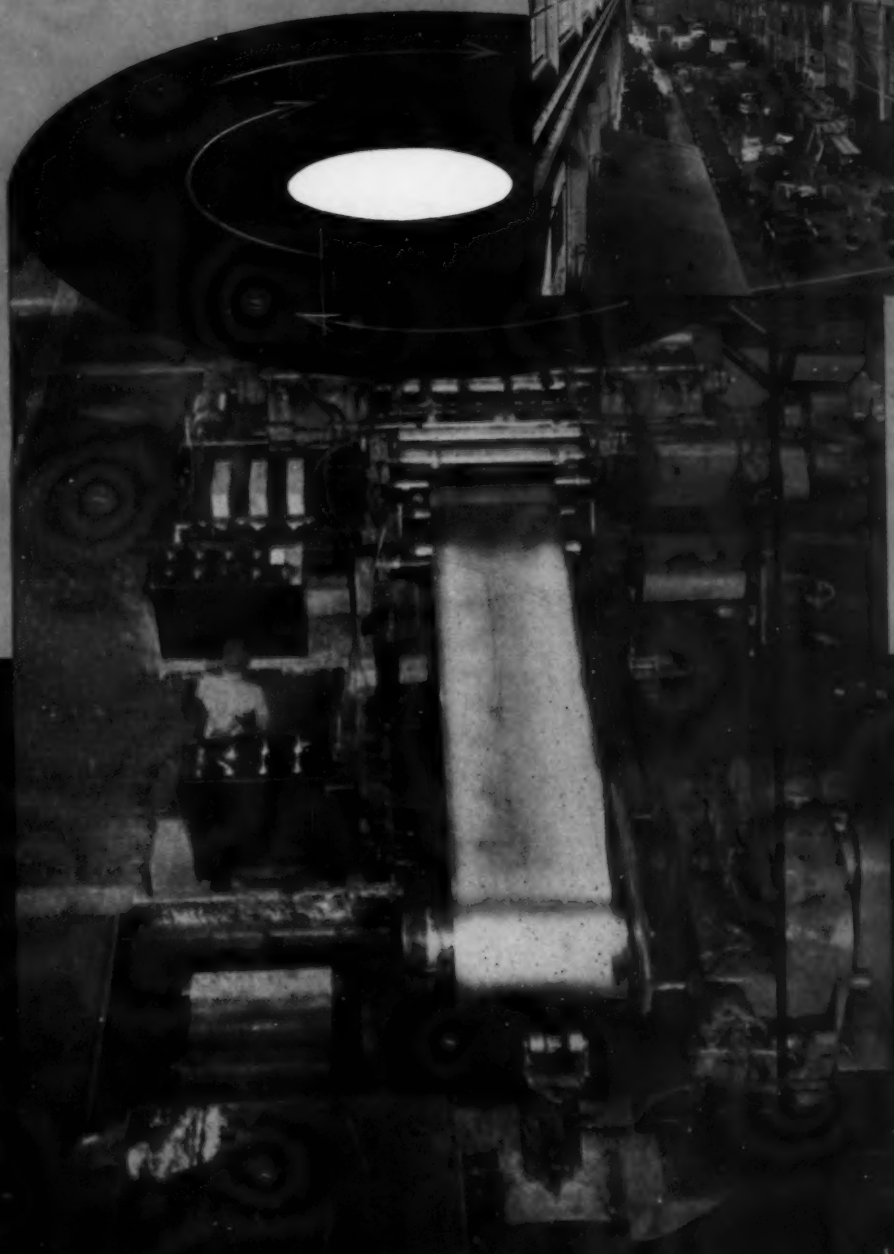
Cutler-Hammer has been so successful in the past in applying the magnetic amplifier to steel mill control schemes, it is very natural that companies looking for best results should come to Cutler-Hammer.

This further adds to Cutler-Hammer's backlog of experience, and gives more positive assurance that the control scheme will properly apply and utilize all the inherent advantages of this dependable control component that has no moving parts, is capable of split-second response and many amazing features. . . . Nothing succeeds like success! CUTLER-HAMMER, Inc., 1269 W. St. Paul Ave., Milwaukee 1, Wis. *Associate:* Canadian Cutler-Hammer, Ltd., Toronto, Ontario.

CUTLER·HAMMER
MOTOR CONTROL
C-H

IRON AND STEEL ENGINEER, published monthly by Association of Iron and Steel Engineers, 1010 Empire Bldg., entered as second class matter January 25, 1924 at Pittsburgh, Pennsylvania, under Act of Congress, March 3, 1879. $7.50 per year in United States and Canada, $10.00 foreign countries. Volume 30, No. 8.

THE AETNA-STANDARD ENGINEERING COMPANY



Leading Engineers and Builders of

FLAT-ROLLED FINISHING EQUIPMENT

Aetna-Standard

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Plants in Warren, Ohio · Ellwood City, Pennsylvania

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Aetna-Standard Engineering Company, Ltd., Toronto, Ontario, Canada.

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Hale & Kullgren, Inc., Akron, Ohio—Representative for the Rubber Industry.

Designers and Builders to the Ferrous, Non-Ferrous, Leather and Rubber Industries

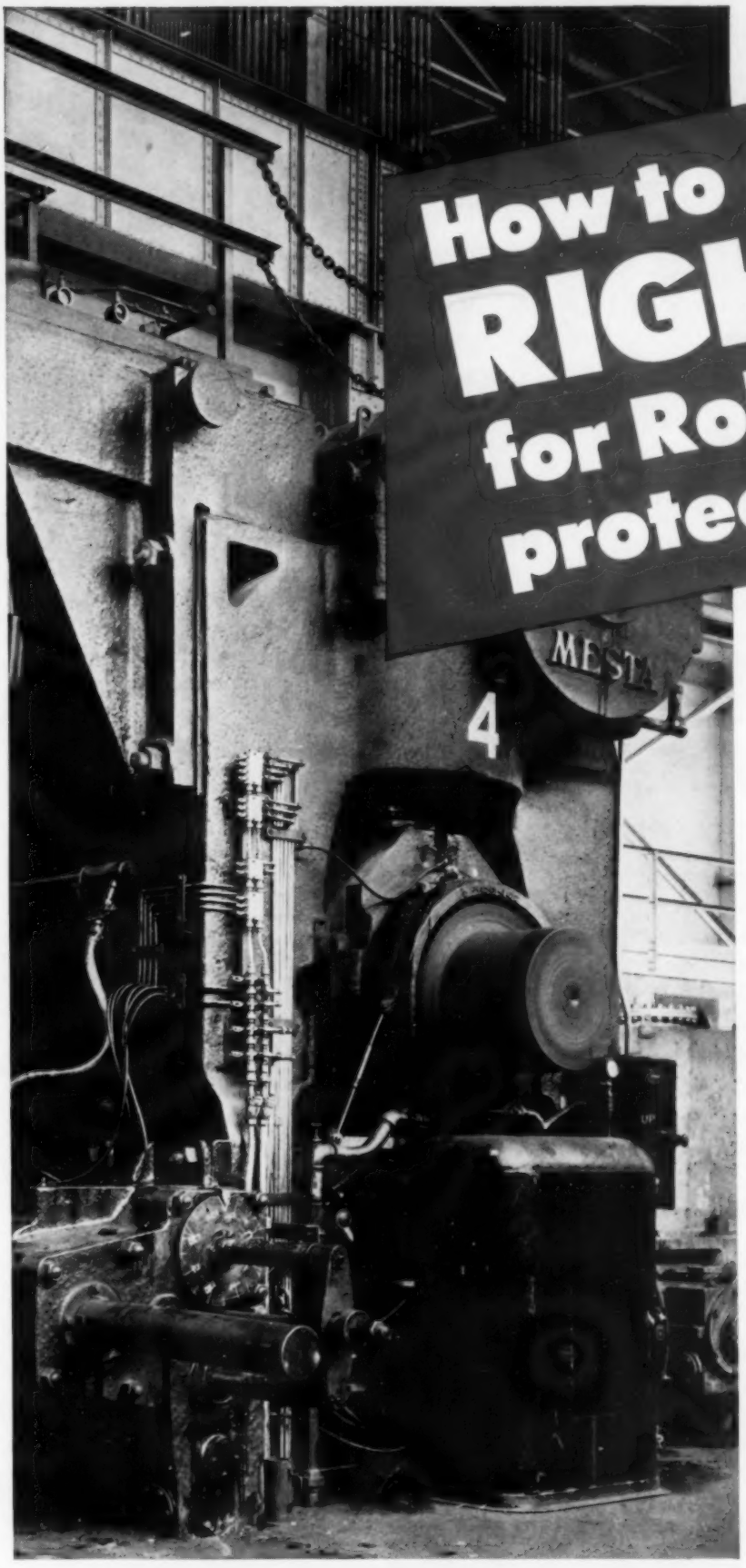
WHY RESEARCH MEANS BETTER ROLLS

At National, continuous investigation of the behavior of iron and steel serves two purposes. The immediate purpose is to control quality of current roll production through analysis of metallurgical specimens. The long range purpose is to search for new formulas and for new and better iron and steel alloys that will keep pace with the technological advance of the steel producing industry. • The results of such a research policy are reflected in the quality and durability of the rolls that National has been producing for forty-five years.

National Rolls

THE NATIONAL ROLL & FOUNDRY CO.
AVONMORE, PENNSYLVANIA

SPECIALISTS IN IRON, ALLOY IRON AND STEEL ROLLS AND CASTINGS, STEEL ARMOR CASTINGS



How to select the RIGHT OIL for Roll Neck protection...

For the oil circulating systems of your roll stands, choose an oil that has high resistance to emulsification, oxidation and sludging. *Texaco Regal Oil* is turbine-quality oil with both these needed characteristics — and *more.*

Texaco Regal Oil separates rapidly from water that may work its way past the seals. This, in conjunction with its high resistance to oxidation, assures that bearings will stay clean and lines clear — free from sludge. *Texaco Regal Oil* thus keeps bearings fully lubricated. Roll necks roll on a film that stands up under the severest conditions. You benefit through smoother operation, longer bearing life, lower maintenance costs.

For your enclosed reduction gears, use *Texaco Meropa Lubricant* — noted for its EP stability, its resistance to oxidation, thickening and foaming.

Let a Texaco Lubrication Engineer help you improve machinery performance and reduce costs throughout your mill. Just call the nearest of the more than 2,000 Texaco Distributing Plants in the 48 States, or write:

The Texas Company, 135 East 42nd Street, New York 17, N. Y.

TEXACO

REG. T.M.

TEXACO Regal Oils

(HEAVY CIRCULATING OILS)

Widest choice . . . *for engineered instrumentation*

EACH of the thousands of industrial processes presents its own peculiar problems of measurement and control. Naturally, no single instrument can solve all of these varied problems. Serious compromises would have to be made in performance, convenience, and cost.

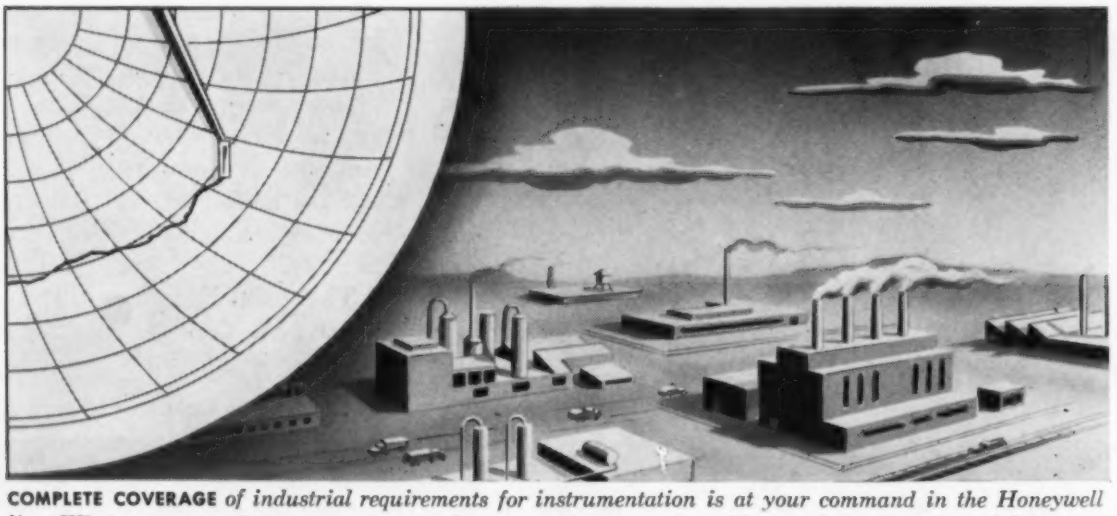
The many Honeywell primary elements, instruments, control systems, and final control elements constitute a uniquely complete family, covering practically the whole spectrum of industrial measurement and control. You can be sure that the combination selected for your job is recommended without bias, and with full consideration for every need of the application.

Included are *ElectroniK* instruments for indicating, recording and controlling a host of variables, in circular and strip chart models; *Tel-O-Set* miniature indicators, recorders and controllers; *Pyr-O-Vane* millivoltmeter controllers; square root and linear flow meters; thermometers; pressure gauges. Electric and pneumatic control systems range from the simplest to the most complex, including fully automatic program control. Primary elements include thermocouples, thermometer bulbs, *Radiamatic* elements, pH assemblies, conductivity cells, flow meter bodies and many others. For final control elements, there is a full range of motorized and diaphragm operated valves. Supplementing these are more than 7000 different non-indicating devices for controlling temperature, pressure, vacuum and other conditions.

"Building block" approach

These are the building blocks of measurement and control. To combine them into systems custom-fitted to your process, Honeywell offers the know-how gained through years of experience in all branches of industry. Whether your process calls for a single instrument or a complete central control panel, you can be sure of getting the peak in performance and value . . . and the advantages of a single responsibility for the entire installation . . . when you specify *engineered instrumentation by Honeywell.*

Efficiency-*coordinates*



COMPLETE COVERAGE *of industrial requirements for instrumentation is at your command in the Honeywell line. Whatever you need to measure or control . . . to any accuracy . . . with any of a variety of special features . . . you'll find Honeywell instruments offer the most efficient solution.*

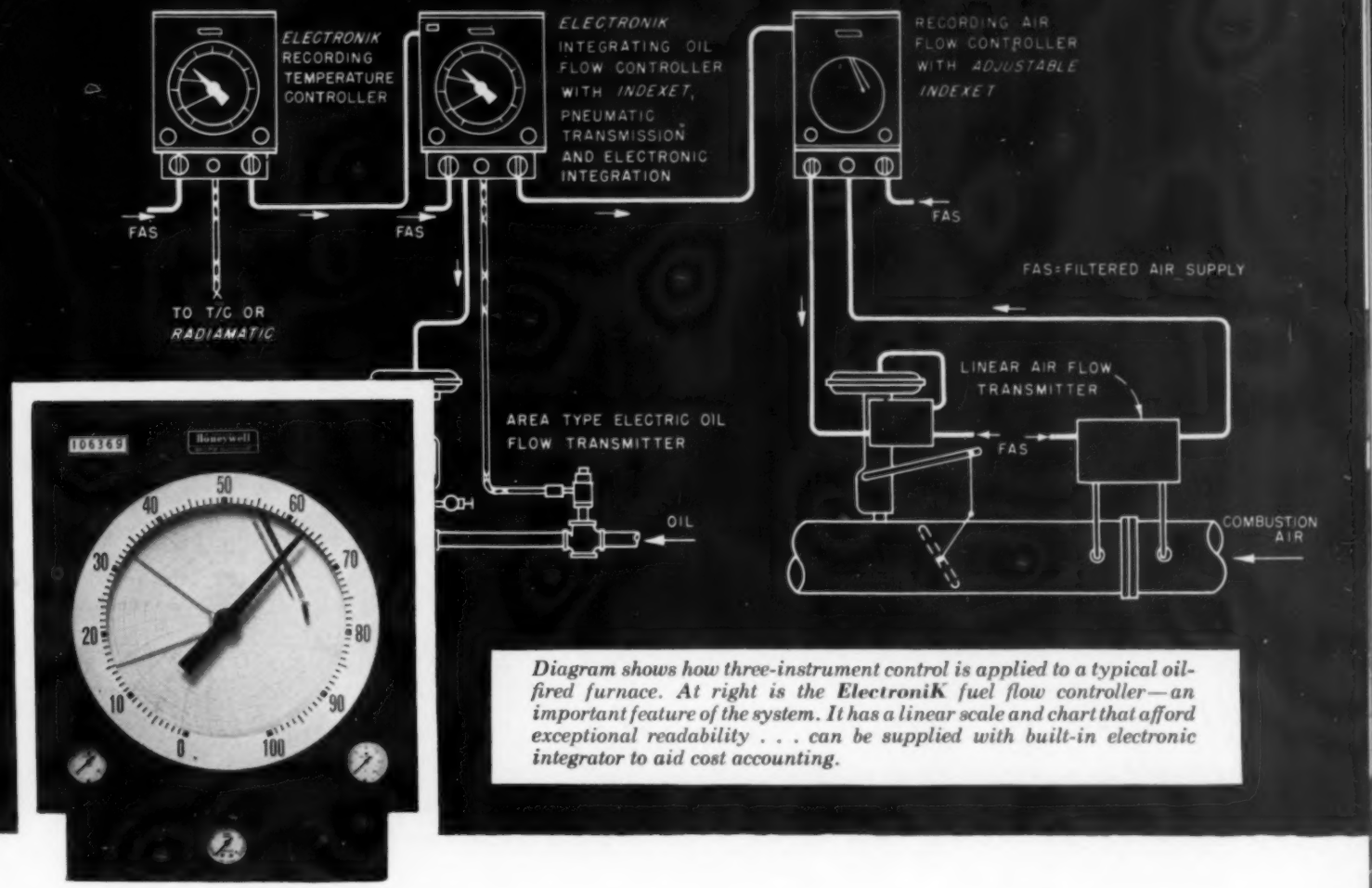


Diagram shows how three-instrument control is applied to a typical oil-fired furnace. At right is the ***ElectroniK*** *fuel flow controller—an important feature of the system. It has a linear scale and chart that afford exceptional readability . . . can be supplied with built-in electronic integrator to aid cost accounting.*

boosting furnace control *temperature, fuel and air*

FUEL-FIRED FURNACES and kilns operate at higher efficiency, and with constant atmosphere . . . when they're regulated by Honeywell Fuel-Air Ratio control. This coordinated system interlocks temperature, fuel flow and air flow . . . keeps air and fuel in constant step with each other . . . proportions both to every change in heat demand.

This three-instrument system is applicable to any fuel-fired furnace. An *ElectroniK* temperature controller resets an *ElectroniK* fuel flow controller . . . which meters fuel, regulates the fuel valve, and, in turn, resets an air flow controller which adjusts combustion air in the desired proportion to fuel.

Outstandingly stable, the system responds quickly, but without cycling. Fuel-air ratio can be adjusted readily to any desired value, and can be biased to compensate for air infiltration or to change ratio at low flows. On dual fuel furnaces, a single switch transfers measurement and control from one fuel to the other.

Call in our local engineering representative for a discussion of your own furnace requirements . . . he is as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, 4464 Wayne Ave., Philadelphia 44, Pa.

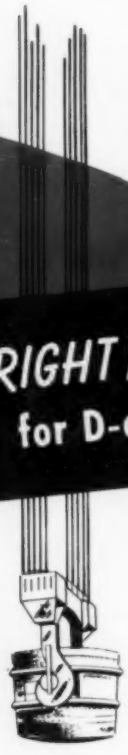
● **REFERENCE DATA: Write for Data Sheet No. 4.3-4a, "Metered Fuel-Air Ratio Control."**

MINNEAPOLIS
Honeywell
BROWN INSTRUMENTS
First in Controls

H HONEYWELL

SAFE CRANE CONTROL

WRIGHT DYNAMIC LOWERING CIRCUIT
for D-c Crane-Hoists



New dynamic lowering circuits for D-c crane-hoists come and go—are superseded by other new circuits, but the well-known EC&M Wright Dynamic Lowering Circuit Hoist Controller continues to be first choice for industrial cranes.

Quick brake-release and fast-operating LINE-ARC Contactors permit accurate spotting of heavy loads—resulting in fewer inching movements, which maintenance men recognize as a contributing factor to reduced upkeep.

Also important is that the operator has direct control (from the Master Switch) of all loads in the lowering direction. The EC&M Wright Circuit is SAFE.

WHEN BUYING CRANES IT PAYS
TO SPECIFY E&M CONTROL

THE ELECTRIC CONTROLLER & MFG. CO.
2698 EAST 79TH STREET • CLEVELAND 4, OHIO

CONTINENTAL

SHOP ASSEMBLY OF A 46" BLOOMING-SLABBING MILL AND 56" TANDEM COLD STRIP MILL AT EAST CHICAGO PLANT

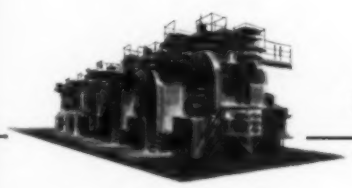
Complete Rolling Mill Installations

SLABBING MILLS	Mills complete with Auxiliary Equipment	BLOOMING MILLS
UNIVERSAL MILLS		STRUCTURAL MILLS
PLATE MILLS	★ ★ ★	RAIL MILLS
HOT STRIP MILLS	CONTINENTAL CHIPPER	BILLET MILLS
COLD STRIP MILLS	ROLL LATHES	ROD MILLS
TEMPER MILLS	SPECIAL MACHINERY	MERCHANT MILLS

CASTINGS—carbon and alloy steel from 20 to 250,000 pounds

ROLLS—iron, alloy iron and steel rolls for all types of rolling mills

WELDMENTS—fabricated steel plate, or cast-weld design.



Plants at
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CHICAGO • PITTSBURGH

CONTINENTAL
Foundry & Machine
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You Can Depend Upon HAGAN Air-Operated Controls and Ring Balance Instruments

- Heat Input Control
- Fuel-Air Ratio Control
- Furnace Pressure Control
- Gas Pressure Control
- Gas Mixing Station Control
- Furnace Reversal Control
- Multiple Fuel Firing Control
- Draft and Pressure Recorders
- Flow Meters for Gases and Liquids
- BTU Meters for Mixed Fuels
- Automatic Pressure and Temperature Compensation for Flow Meters

The production of steel presents complex metering and control problems. Wherever steel is made, Hagan Air-Operated Controls and Ring Balance Instruments solve these problems smoothly and efficiently. Simply designed and sturdily built, Hagan equipment combines the utmost in reliability and accuracy with a minimum of maintenance and operating expense. Applicable to all phases of the steel industry, Hagan Automatic Controls and Instruments assure dependable service.

Experienced Hagan engineers are ready to help you solve your metering and control problems. For information, write, wire or phone

HAGAN CORPORATION

HAGAN BUILDING, PITTSBURGH 30, PA.

BOILER COMBUSTION CONTROL SYSTEMS
RING BALANCE FLOW AND PRESSURE INSTRUMENTS
METALLURGICAL FURNACE CONTROL SYSTEMS
CONTROL SYSTEMS FOR AERONAUTICAL
AND AUTOMOTIVE TESTING FACILITIES

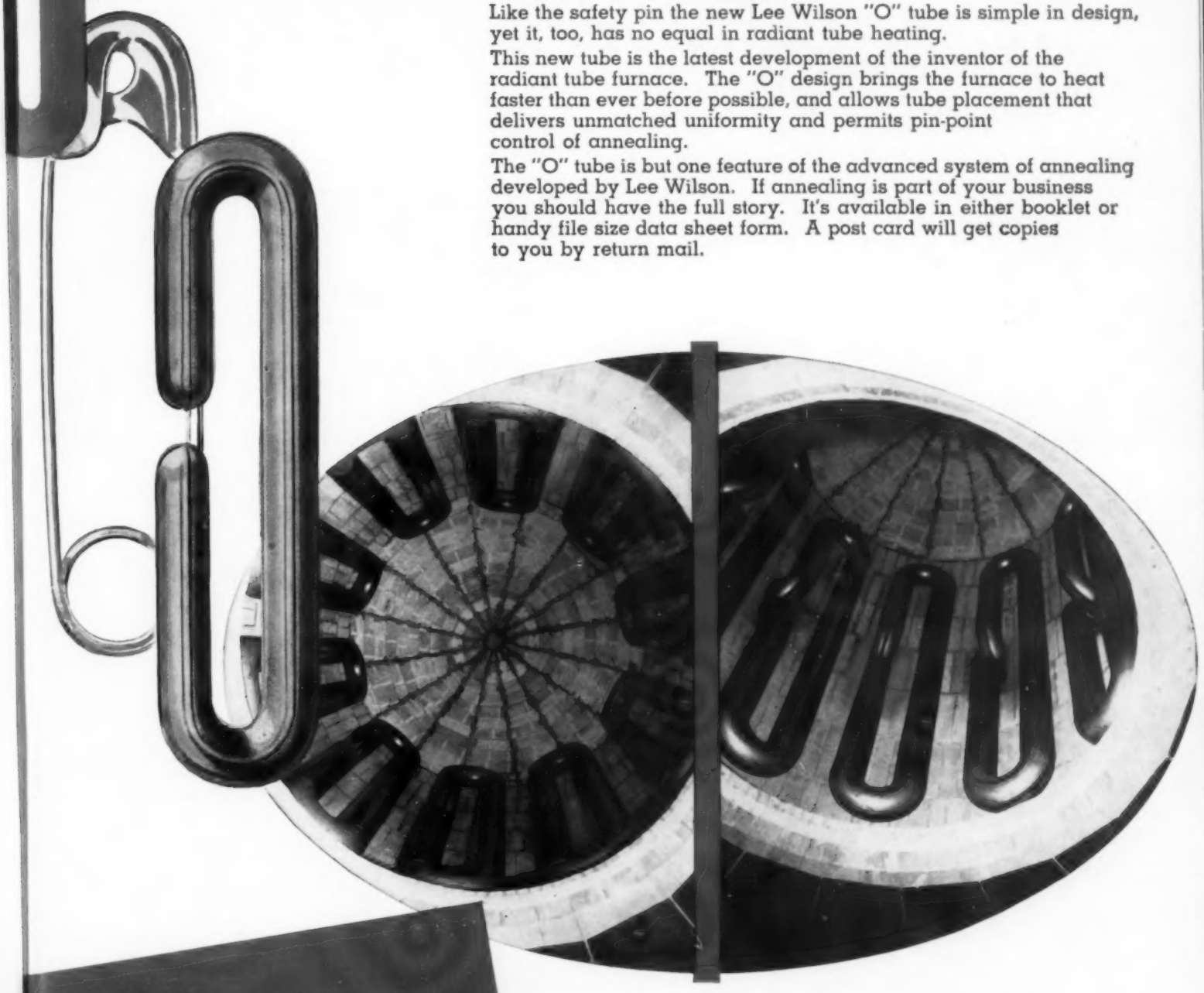
Simple--LIKE A SAFETY PIN

The safety pin was a simple invention — yet, as any new mother will testify, it has no substitute.

Like the safety pin the new Lee Wilson "O" tube is simple in design, yet it, too, has no equal in radiant tube heating.

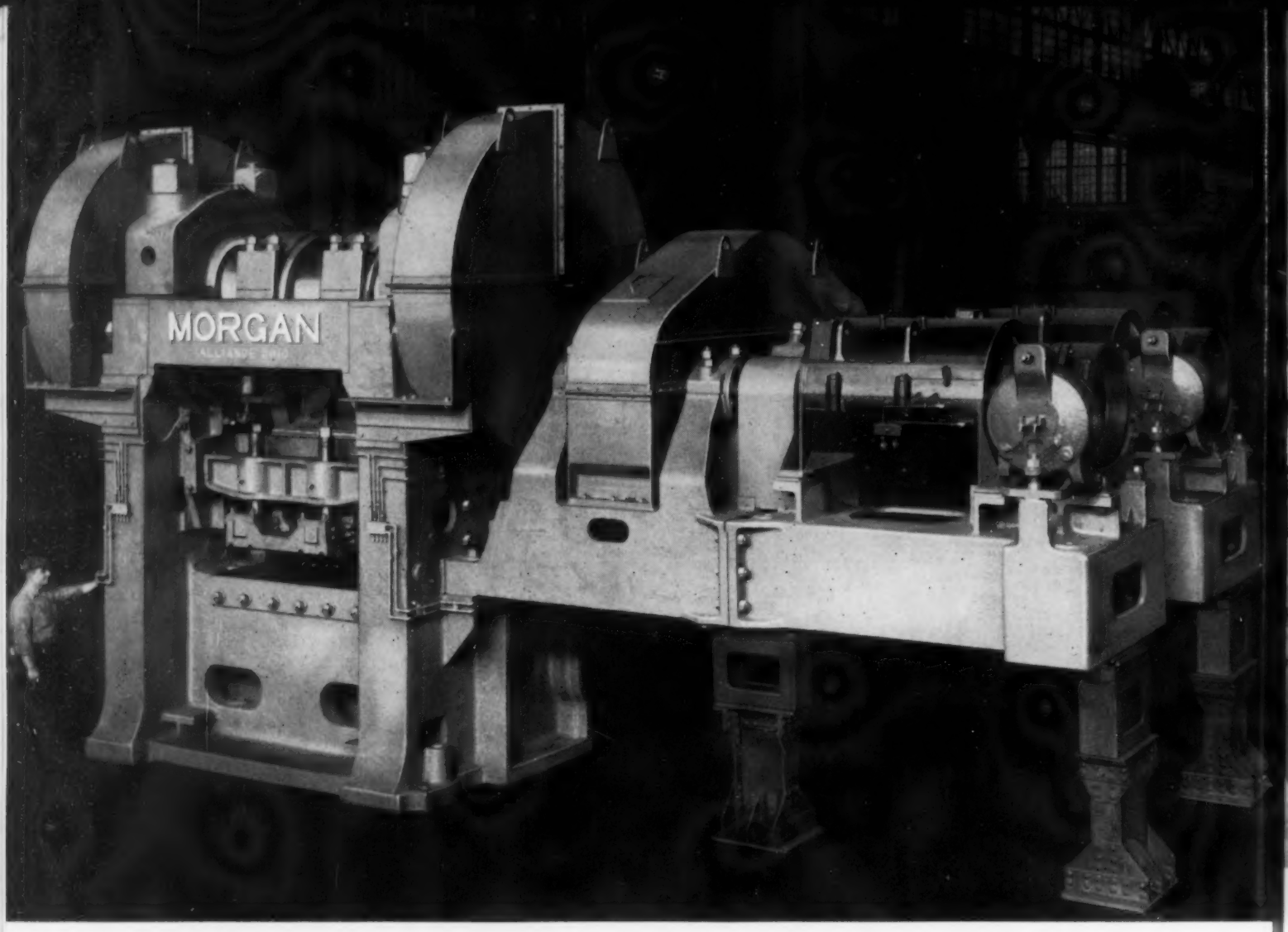
This new tube is the latest development of the inventor of the radiant tube furnace. The "O" design brings the furnace to heat faster than ever before possible, and allows tube placement that delivers unmatched uniformity and permits pin-point control of annealing.

The "O" tube is but one feature of the advanced system of annealing developed by Lee Wilson. If annealing is part of your business you should have the full story. It's available in either booklet or handy file size data sheet form. A post card will get copies to you by return mail.



Lee Wilson ENGINEERING COMPANY, INC.

20005 WEST LAKE ROAD • CLEVELAND, OHIO



1200-TON DOWN CUT SLAB SHEAR

BUILT BY MORGAN Engineering

DESIGNERS • MANUFACTURERS • CONTRACTORS

BLOOMING MILLS • PLATE MILLS • STRUCTURAL MILLS

ELECTRIC TRAVELING CRANES • CHARGING MACHINES

INGOT STRIPPING MACHINES • SOAKING PIT CRANES

ELECTRIC WELDED FABRICATION • LADLE CRANES

STEAM HAMMERS • STEAM HYDRAULIC FORGING PRESSES

SPECIAL MACHINERY FOR STEEL MILLS

THE MORGAN ENGINEERING CO.

ALLIANCE, OHIO PITTSBURGH—1420 OLIVER BUILDING

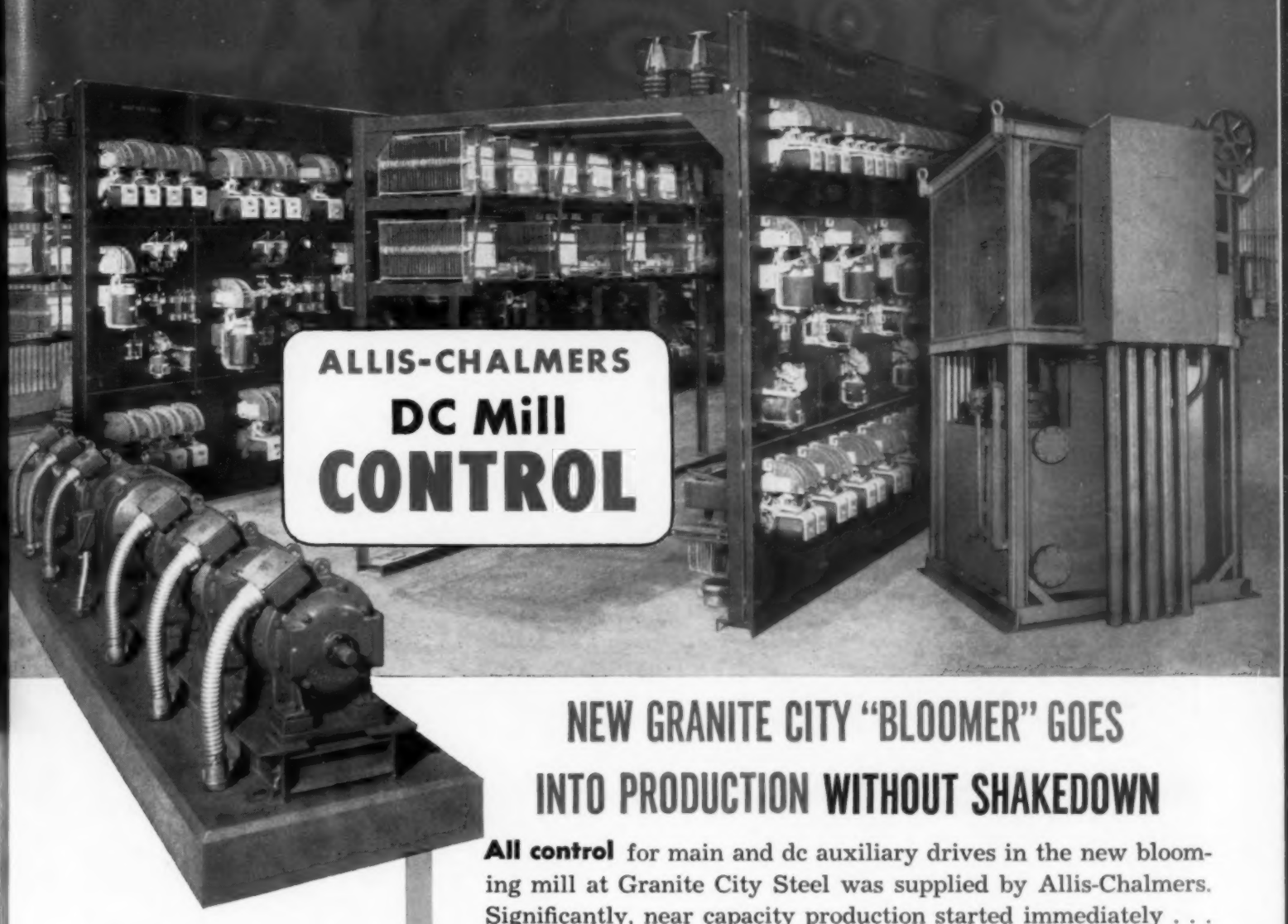
Illustrated is a 1200-ton hot Slab Shear of the start-stop type with twin-motor drive.

Shear has a 12″ stroke. Designed to cut maximum 51″ wide x 6″ thick stainless steel and 60″ wide x 7″ thick carbon steel slabs.

Cutting speed eight (8) strokes per minute.

Your inquiries for mill equipment will be appreciated.

A Fast Start!



NEW GRANITE CITY "BLOOMER" GOES INTO PRODUCTION WITHOUT SHAKEDOWN

All control for main and dc auxiliary drives in the new blooming mill at Granite City Steel was supplied by Allis-Chalmers. Significantly, near capacity production started immediately . . . without a costly shakedown. In fact, eight days later the old mill was taken out since it was apparent that standby equipment was not needed.

Noteworthy, too, is the fact that the installation was completed *on time*. Controls were factory assembled, thus simplifying and speeding installation.

Progressive Granite City Steel has standardized on Allis-Chalmers electrical equipment in its large expansion program. The recently completed blooming mill is the first stage in a three-stage plan. When completed, this realistic, farsighted expansion will push production to well over a million ingot tons annually.

Why not put Allis-Chalmers skill and experience to work for you? Call your nearby A-C steel mill representative or write Allis-Chalmers, Milwaukee 1, Wisconsin.

A-4114

Pictured above are some of the Allis-Chalmers control installations at Granite City Steel.

Left — *Regulex* amplifier exciter sets provide sensitive control for variable voltage dc drives.

Center — Constant voltage control panels for dc auxiliary drives.

Right — Liquid rheostat provides stepless speed control for 7000-hp m-g set.

Regulex is an Allis-Chalmers trademark.

ALLIS-CHALMERS

A-C ALLIS-CHALMERS

12% increase in production over other natural draft furnaces in the mill

11% decrease in fuel burned per ton

. . . that is the 2-year record of this Morgan-Isley controlled open hearth at the Alan Wood Steel Company

The open hearth has a 125-ton capacity, burns up to 500 gallons of oil per hour operating on a hot charge. Primary and extra large secondary checkers (permitted by Morgan-Isley design) trap most of the heat. The flue gas enters the base of the secondary regenerators at about 1600°F. The stack temperature averages about 750°F. The low stack temperature and the exceptionally large heat storage result in the tonnage increase and fuel saving shown above.

Let us tell you more about Morgan-Isley.

CCC39

MORGAN CONSTRUCTION COMPANY WORCESTER, MASS.

ROLLING MILLS • MORGOIL BEARINGS • REGENERATIVE FURNACE CONTROLS • EJECTORS • PRODUCER GAS MACHINES

PITTSBURGH, PA., 2815 Koppers Bldg. *English Rep.*, International Construction Co., 56 Kingsway, London W. C. 2, England

...with TYCOL lubricants on hand!

The "All-Weather" Bearing Lubricant! Steel mills have shown a lively interest in Tycol Acylkup 4, a year 'round bearing grease that does a variety of jobs with a complete disregard for thermometer readings. Although all methods of application are suitable, one "3-Furnace" mill has found it particularly adaptable for use in its automatic grease systems – with complete ease of pumping even in the coldest weather. From Blast furnaces: Sheave Bearings, Bell Mechanism, Skip Hoists, etc. . . . to Coal and Ore Bridges, Tycol Acylkup 4 is a natural for lubricating yard equipment in every steel mill. With two big savings: "all weather" protection . . . and lowered maintenance costs on automatic pressure systems. For details, contact your local Tide Water Associated office!

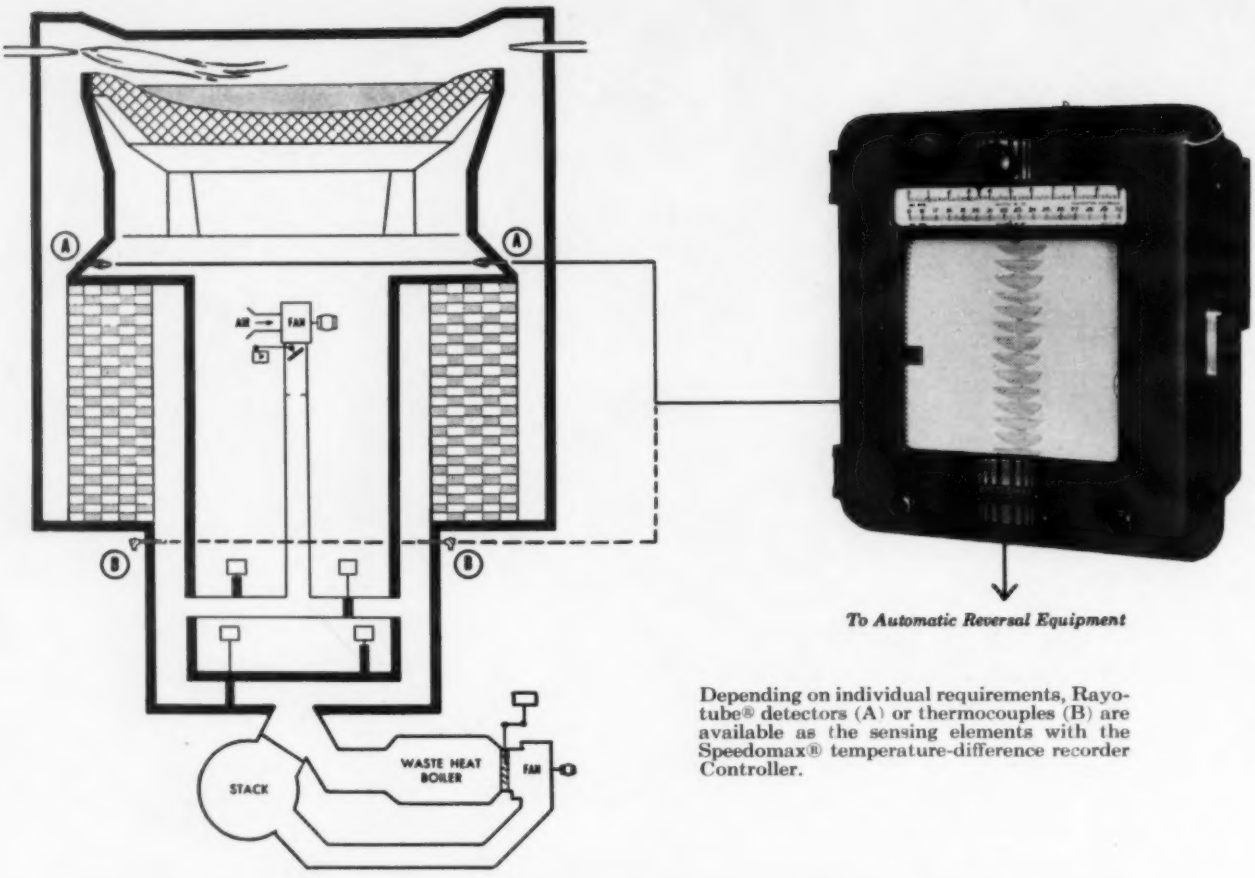
TYCOL
INDUSTRIAL LUBRICANTS

Boston • Charlotte, N. C. • Pittsburgh
Philadelphia • Chicago • Detroit
Tulsa • Cleveland • San Francisco
Toronto, Canada

Over 300 Tycol industrial lubricants are at your disposal . . . engineered to fit the job!

REFINERS AND MARKETERS OF VEEDOL . . . THE WORLD'S MOST FAMOUS MOTOR OIL

TIDE WATER ASSOCIATED OIL COMPANY
17 BATTERY PLACE - NEW YORK 4, N.Y.



Depending on individual requirements, Rayotube® detectors (A) or thermocouples (B) are available as the sensing elements with the Speedomax® temperature-difference recorder Controller.

Now...One Instrument Replaces Two

FOR RECORDING AND CONTROLLING OPEN-HEARTH REVERSAL

● The single Speedomax instrument shown here replaces both the Recorder and the Controller otherwise used for reversal-control of open-hearths, glass tanks and other big, checker-chambered regenerative furnaces. This simplified equipment not only saves valuable panel space, but gives the helpers just one instrument to read instead of two. There's therefore less chance of the kind of poor operation which is based on incorrect reading; more operating information of value and, of course, there's just half as much instrument maintenance.

Like the two-instrument equipment, this Recording Controller also helps bring about various savings, some direct and some indirect. It can save most of the labor of switching the dampers every time the direction of firing is changed. It helps speed up the heating rate; helps maintain uniform heat; helps hold a good balance of temperature between checkers at opposite ends of the furnace. It's an automatic, always-on-the-job helper for the First Helper.

Features Include:

1. Record shows both the fall in temperature of the checker which is on air, and the rise in the one on combustion-product gas.

2. Signal arrows on Controller case show direction in which flame is traveling.

3. Controller is readily tied in with any reversal control mechanism. It does not interfere during any condition that requires manual control. First Helper can throw onto manual, and back again, at any time; there's nothing to reconnect or reset.

4. An overheat safety feature can be used to reverse furnace at pre-set temperature limit, regardless of temperature difference.

This Controller can be installed on any existing furnace, to improve operation and prolong refractory life.

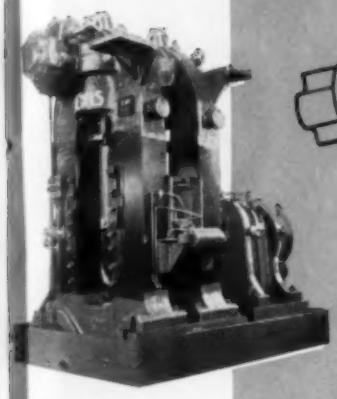
You'll find full facts about Speedomax Reversal Control in these Demonstration Sheets; please contact our nearest office for a set, or write us at 4942 Stenton Avenue, Philadelphia 44, Pa.

Send for free Demonstration Sheets

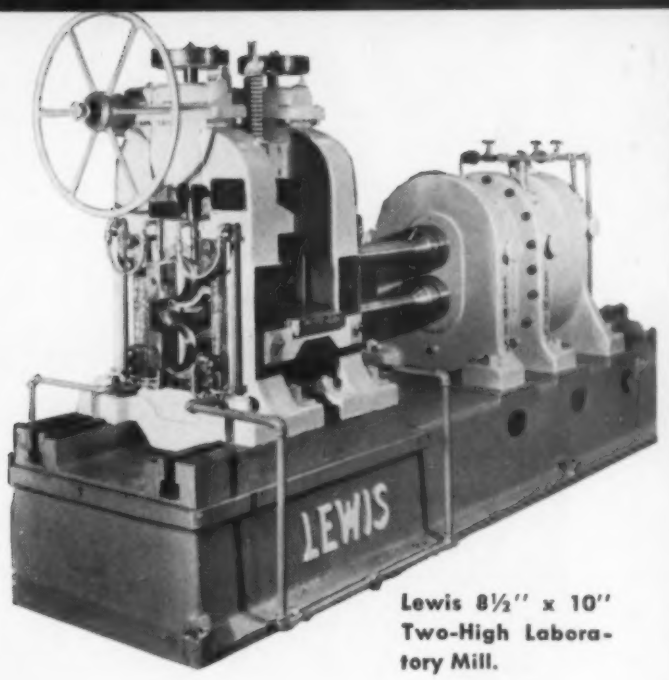
LEEDS NORTHRUP

instruments — *automatic controls • furnaces*

Jri Ad ND46-33-643(1b)

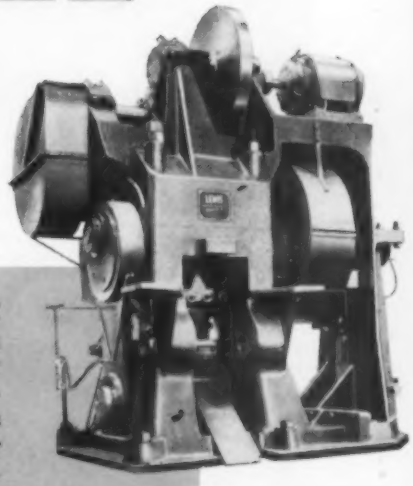


10" and 24" x 20" Four-High Reversing Mill Stands.



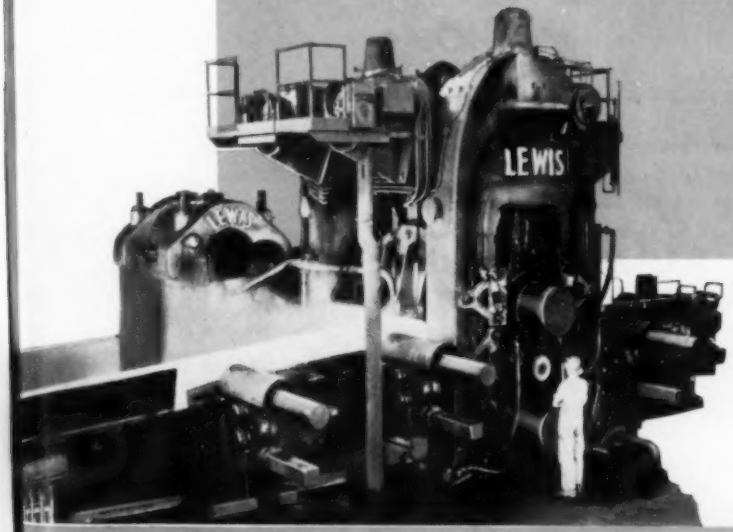
Lewis 8½" x 10" Two-High Laboratory Mill.

LEWIS ROLLING MILL EQUIPMENT



Exit side of Lewis 8" x 8" Up-Cut Shear.

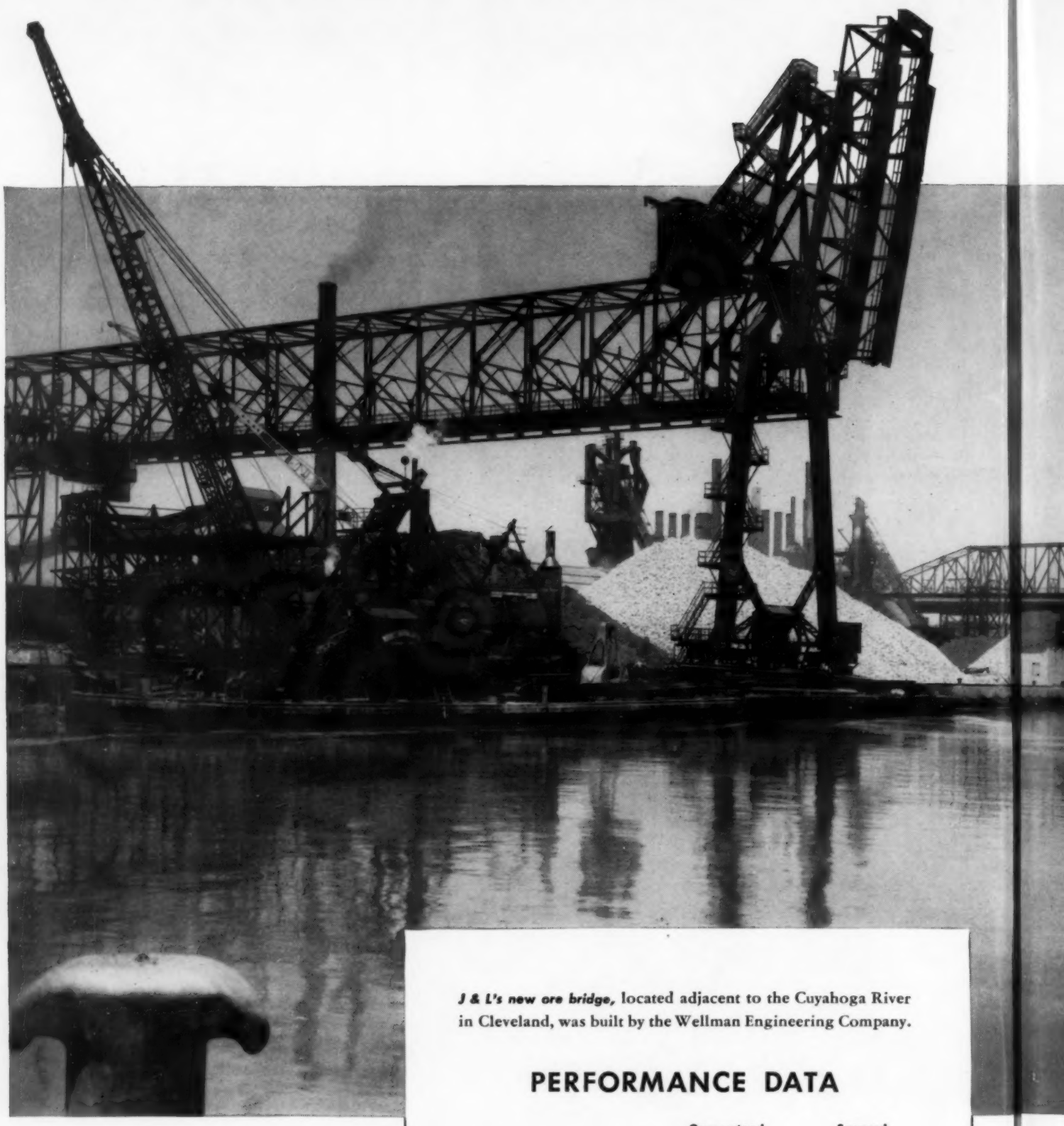
Lewis equipment will meet *all* your requirements whether you are modernizing your plant or increasing your rolling mill facilities. You can call on Lewis for a small laboratory mill, shear or a large plate mill—or anything in between. Lewis' ability to design and build efficient, cost-reducing machinery for rolling steel and non-ferrous metals is known throughout the industry.



26½" and 42" x 112" Three-High Balanced Finishing Plate Mill.

BLAW-KNOX

BLAW-KNOX COMPANY
LEWIS MACHINERY DIVISION
PITTSBURGH 22
PENNSYLVANIA



J & L's new ore bridge, **located adjacent to the Cuyahoga River in Cleveland, was built by the Wellman Engineering Company.**

PERFORMANCE DATA

	Guaranteed	Secured
Hoist Speed	260 fpm	280 fpm
Lower Speed	286 fpm	314 fpm
Trolley Speed	1200 fpm	1290 fpm
Average Trolley Acceleration Rate	3.0 ft/sec^2	3.02 ft/sec^2
Cycle Time	58.6 sec	57 sec
Unloading Capacity	1040 tons/hr	1070 tons/hr

Westinghouse drive boosts ore bridge performance

This 573-foot giant at the Otis (Cleveland) Works of Jones & Laughlin unloads ore from Great Lakes carriers at a 1040-ton-per-hour rate. The control system and drive, designed and built by Westinghouse, have integrated the bridge's complex electrical system. In addition, they offer power savings and low maintenance.

Smooth-sailing bucket

Westinghouse applied a new adjustable-voltage drive which gives the operator smoother, more precise control of the 17-ton capacity bucket. A special load-regulating system governs the distribution of load between the "hold" and "close" drives, and controls the bucket under all operating conditions.

Trolley with pickup

The drive provides fast acceleration for the trolley and reduces peak stresses on the mechanical parts and structural members. It assures economical operation by practically eliminating acceleration power losses. In addition, it lessens bridge maintenance costs and permits trolley construction of lighter weight, a saving reflected throughout the entire bridge.

No speeding allowed

Thanks to automatic, interlocked controls, the operator's job is relatively simple. In an emergency, he can remove power from all driving motors and set the brakes by touching the "stop" button. Trolley travel protection is provided by limit switches which enforce two speed check points at each end of travel. If the trolley exceeds its prescribed speed when it passes either of these check points, it's automatically slowed down.

Next time, call Westinghouse

Co-operation between J & L, Wellman and Westinghouse engineers produced a drive characterized by smooth, rapid acceleration and excellent maneuverability. Westinghouse also builds drives for conveyers, cranes, shovels . . . for almost all kinds of materials-handling equipment. If you can use this kind of imaginative engineering, call your nearby Westinghouse office early in the planning stage. Westinghouse Electric Corp., Pittsburgh, Pa. J-94973

YOU CAN BE SURE...IF IT'S

Westinghouse

DOWN GOES DOWN-TIME with Permanente 84!

In this report from a major steel mill you'll find convincing evidence that you can drastically reduce down-time for hot repair with Permanente 84 ramming and patching mix.

"Open hearths are operating well under usual heat times. Last month, heat time from tap to tap averaged seven minutes less than the previous best month on record. The use of Permanente 84 has helped cut delay time in half!"

Faster hot repair is possible with Permanente 84 because it's easy to use. Fewer repairs are needed between heats because it gives superior bottom performance.

Act now! Start using Permanente 84 for open hearth and electric furnace rebuilds as well as for bottom, bank and tap hole maintenance.

SEND FOR BOOKLET giving all the important advantages of Permanente 84 and the companion material, Permanente 165. Upon request, your Kaiser refractory engineer will promptly offer you research, design and installation service to help you obtain more steel tonnage per year, at lower bottom cost per ton. Call or write principal sales offices: *Chemical Division,* Kaiser Aluminum & Chemical Sales, Inc., 1924 Broadway, Oakland 12, California. First National Tower, Akron 8, Ohio.

Kaiser Chemicals

Pioneers in Modern Basic Refractories

Basic Refractory Brick and Ramming Materials • Dolomite • Magnesia • Magnesite • Alumina • Periclase

UNITED

ENGINEERING AND FOUNDRY COMPANY

PITTSBURGH, PENNSYLVANIA

Plants at: PITTSBURGH • VANDERGRIFT • NEW CASTLE • YOUNGSTOWN • CANTON

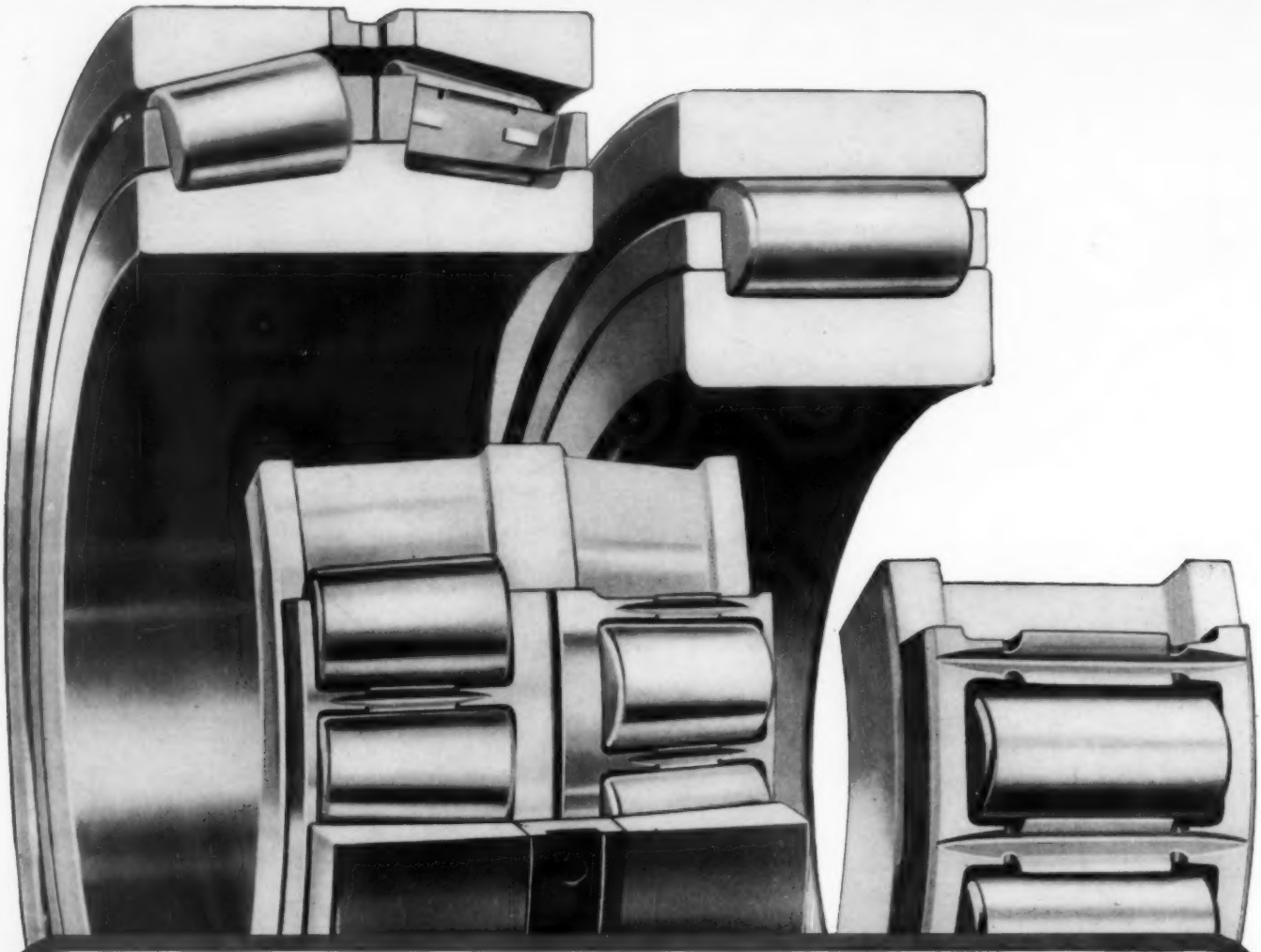
Subsidiaries: ADAMSON UNITED COMPANY, AKRON, OHIO
LOBDELL UNITED COMPANY, WILMINGTON, DELAWARE
STEDMAN FOUNDRY AND MACHINE CO., INC., AURORA, INDIANA

Designers and Builders of Ferrous and Nonferrous Rolling Mills, Mill Rolls, Auxiliary Mill and Processing Equipment, Presses and other Heavy Machinery. Manufacturers of Iron, Nodular Iron and Steel Castings, and Weldments.

HIGH SPEED

CONTINUOUS

ANNEALING LINE



TORRINGTON

TAPERED and CYLINDRICAL ROLLER BEARINGS

Give you these BIG ADVANTAGES

- **One-piece cast-bronze cages with machined pads in each roller pocket**—to assure accurate guiding of rollers.
- **Stabilized races**—to maintain accuracy of fit, improve bearing performance.
- **Individual roller retainment**—to assure adequate lubrication at roller, simplify inspection of race surfaces.
- **Precision tolerances and finishes on both rollers and races**—for minimum eccentricity and equal load distribution.
- **Controlled quality steels**—by use of electric furnace steels, through-hardening or case-hardening grades, and modern heat-treating methods—for increased bearing capacity and longer life.
- **Interchangeability**—in all types and sizes.

Backed by custom engineering to meet your load and speed requirements, these advantages add up to maximum performance for your bearing dollar. That's why it always pays to specify TORRINGTON!

THE TORRINGTON COMPANY

South Bend 21, Ind. • Torrington, Conn.

TORRINGTON BEARINGS

Spherical Roller • Tapered Roller • Cylindrical Roller • Needle • Ball • Needle Rollers

H. J.
Here's a really fantastic letter!
P.W.

BANNER TOOL COMPANY

BANNER tools DETROIT — *Fine* TOOLS FOR INDUSTRY

17243 FILER AVENUE - TWINBROOK 2-4900

DETROIT 12, MICHIGAN

June 16, 1952

Cities Service Oil Co.,
3049 E. Grand Blvd.,
Detroit 2, Michigan
Attention: Mr. P. E. Watts

Dear Sirs:

We called upon the services of your lubrication engineer, Mr. A. J. Blake, in reference to a serious staining condition which we were having with our soluble oil. He analyzed this condition and recommended one of your Chillo Oils. This oil was tried and the rust condition eliminated to our satisfaction.

To our surprise on his next visit he was dissatisfied with our tool life and suggested we use a soluble oil called "Chillo A". Now not only do we have clean machines, but tool life has been increased 20%! While in our plant he asked permission to "look around", which, of course, was granted.

We were using a tapping compound with precision ground taps in order to hold to close tolerances. We did not consider tap breakage excessive but the removal of broken taps was sometimes rather expensive. He recommended we use "Chillo 10Z". Then came the surprise of our lives! With Chillo 10Z we have gone to commercial ground taps (a 300% savings) and can still hold our same tolerances, with a sharper thread, increasing tap life a minimum of 20% plus eliminating expensive removal of broken taps!

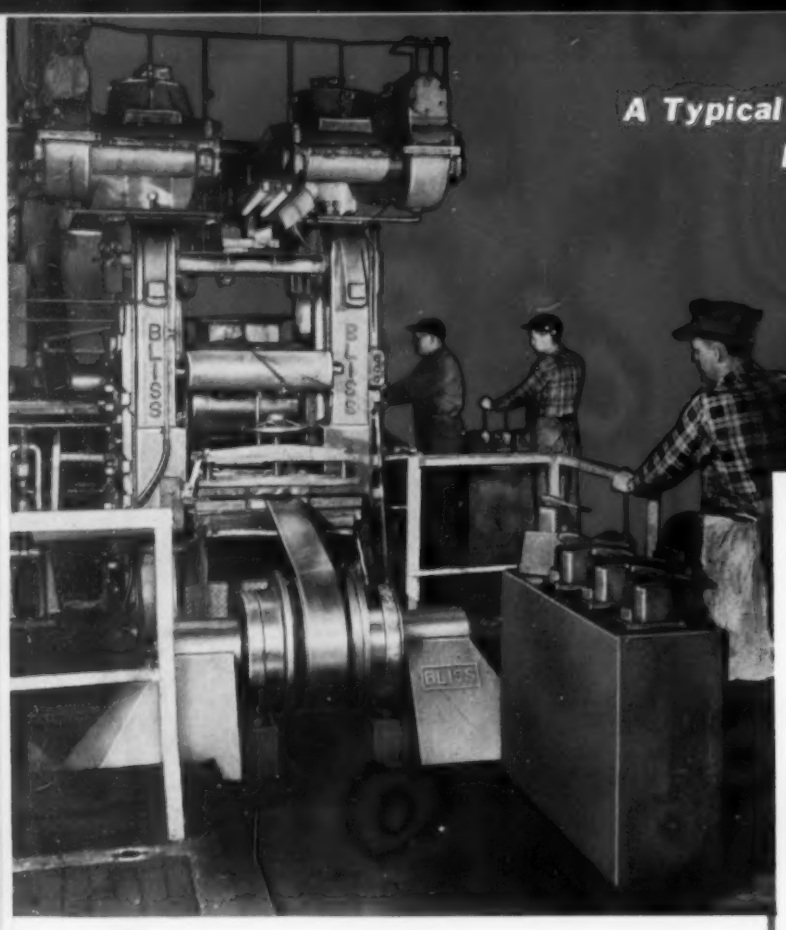
We also have a production stamping job which required a new set of dies every month. On his recommendation we tried Chillo 10Z with these dies. Now our die life has increased to at least two months...a saving in die life of 100%, disregarding labor costs. We also increased production 200% per die sharpening!

We tried the same oil on our broaching operation and found that instead of making two cuts we can get the same results now with one. We were using one of your competitors' hydraulic oils and you told us it was a "good oil" and would give us satisfactory performance. BUT, GENTLEMEN, WITH THE EXCELLENT SERVICE YOU HAVE GIVEN, PLUS THE TIME AND MONEY SAVED, YOU MAY REST ASSURED THAT ALL OF OUR LUBRICATING REQUIREMENTS WILL BE PURCHASED FROM YOU.

Yours very truly,
BANNER TOOL COMPANY

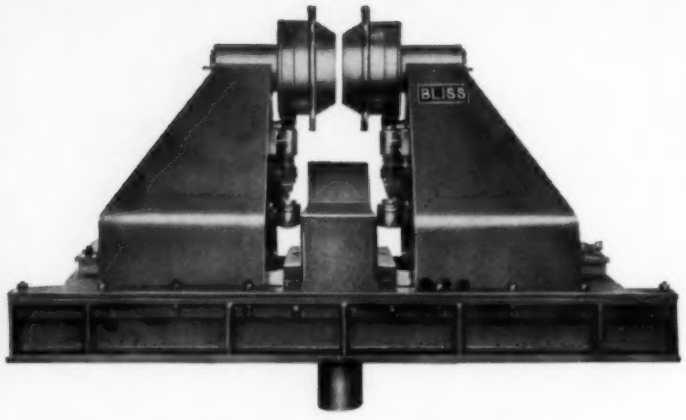
S. F. OLESAK

SFO:sd



A Typical Example of Bliss Service
Revitalizing Existing Equipment

at Thomas Strip Division
PITTSBURGH STEEL CO.
Warren, Ohio



PNEUMATIC BRAKE, directly beneath the drums, controls tension to prevent over-running of coil. Loading ramp, with coil stops, located beneath floor level, can be used to speed coil handling.

Bliss Unwinder

Eliminates Scratching of Strip...

BOOSTS PRODUCTION 15%

THOMAS STRIP DIVISION, Pittsburgh Steel Co., has licked the problem of scratching their high carbon and No. 3 finish steel strip. They've installed a Bliss cone-type double-stub unwinder that feeds their strip quickly and smoothly, without looping or over-running. And, as Assistant General Superintendent M. D. Blasier reports: "We not only retain perfect surface characteristics and eliminate scratches—we've also increased our production by 15% with the Bliss unwinder."

In this particular installation, the Bliss unwinder is used with a Bliss 4-high mill. But it can be used with practically any mill and render *the same satisfactory results*. Additional refinements such as the drag generator tension control and the automatic strip-alignment feature are often provided with this type unit.

Bliss' 52-page Rolling Mill Brochure describes the unwinder and other accessory equipment that can help you up-grade speed and quality in your mill. It's a valuable source of production ideas. Send for a copy, study it, and then call Bliss' Engineering Department for a frank appraisal of your problem. That's what Thomas Strip Division did!

E. W. Bliss Company · General Office: Canton, Ohio

ROLLING MILL DIVISION: SALEM, OHIO

E. W. Bliss (England) Ltd., Derby, England

E. W. Bliss Company (Paris), St. Ouen sur Seine, France

U. S. Plants in Canton, Salem and Toledo, Ohio; and Hastings, Michigan

Branch Offices in Chicago, Cleveland, Dayton, Detroit, Indianapolis, New Haven New York, Philadelphia, Rochester, Toledo; and Toronto, Canada.

West Coast Representatives: Moore Machinery Company, Los Angeles and San Francisco; Star Machinery Company, Seattle. *Other dealers* in United States cities and throughout the world.

Remember:

for Presses, ROLLING MILLS and Special Machinery . . .

It's Bliss

Patent Reviews

By MELVIN NORD
Patent Attorney
Detroit, Mich.

. . . . copies of patents may be obtained from the Commissioner of Patents, Washington 25, D. C., at 25 cents each . . . . patents reviewed cover period April 21 through May 12, 1953 . . . . .

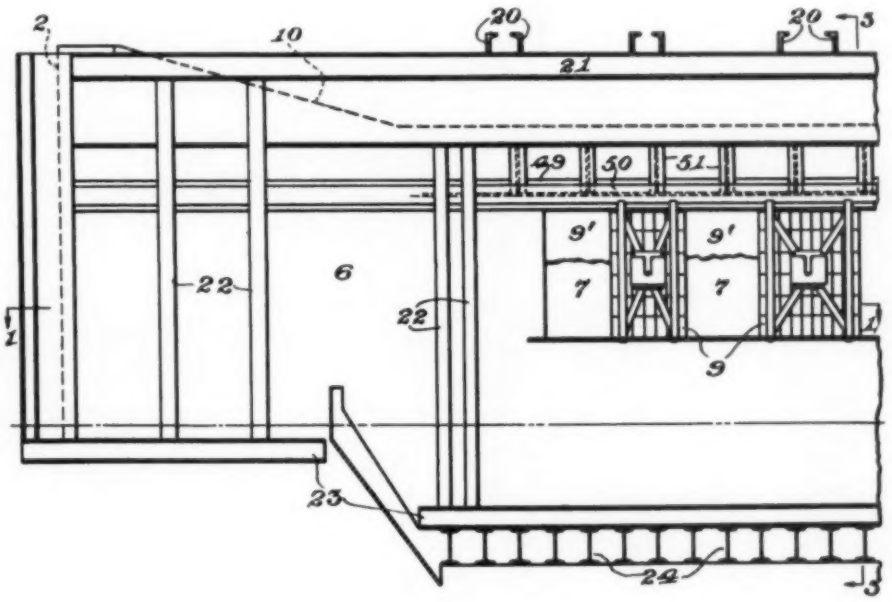
SELF-CONTAINED REPLACEABLE PANELS FOR OPEN HEARTH FURNACES

▲The object of U. S. 2,637,286 is to provide improvements in open hearth furnaces, which normally consist of one or more fixed integral piers between the charging doors, but which in this invention are replaced by an equal number of readily removable panels. The patent was issued May 5, 1953 to Russell Pearce Heuer and assigned to General Refractories Co.

The provision of removable and replaceable panels provides for their independent removal, substitution, and repair. Furthermore, a single wide opening of the entire charging door area may be provided if desired, so that instead of placing relatively small quantities of scrap in the furnace at spaced intervals, an evenly distributed charge may be injected into the structure all at once.

The construction described also permits the elimination of all buck stays within the longitudinal limits of the door area, and instead provides for the support and transverse restraint of the roof by vertically and transversely rigid structural steel elements of channel, I-beam, and similar forms by the opposite end portions of the metal framework of the furnace.

Figure 1



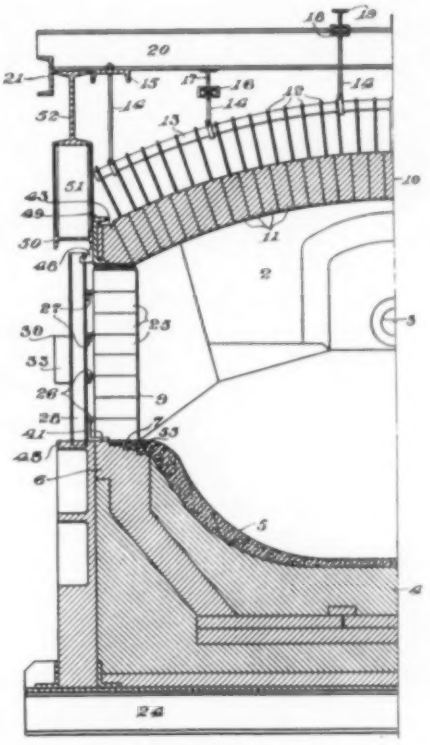


Figure 2

The panel 9, as illustrated in Figures 1, 2, and 3, is essentially a rectangular assembly of refractory bricks 25

normally positioned in place of the fixed pier which it replaces, between charge openings 7. These bricks are carried by a permanent framework. They are detachably supported by hangers 26 on brackets 27, which are in turn welded to a pair of spaced, vertical I-beams 28, secured together and braced by diagonal tie members 29 which are welded together. A lifting bracket 30 is provided to permit lifting of the panel as a unit by means of the peel shank 35 of a loading mechanism.

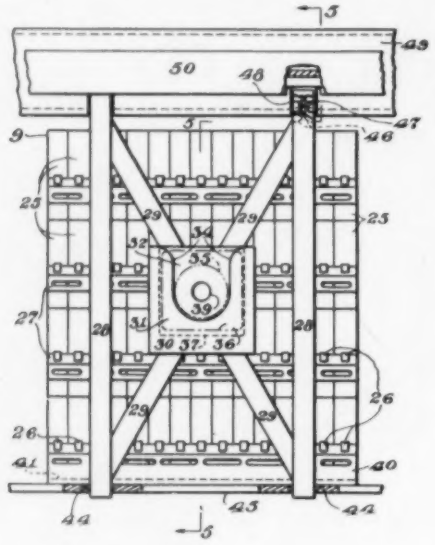


Figure 3

The frontal skewback channel 49 is stiffened by an I-beam 50, preferably water-cooled, which is supported by spaced, vertical I-beam 51 welded to the under side of a large I-beam 52, which is in turn supported by the under side of the spaced I-beams or channels 20 of the superstructure.

SUPERSONIC WIRE DRAWING PROCESS

In U. S. 2,638,207, issued May 12, 1953 to Robert P. Gutterman and assigned to Engineering Research Associates, Inc., drawing of wire is done by a process which involves vibration of the die at a small amplitude and a frequency in the supersonic range, and in the direction of the drawing motion. It is claimed that the force necessary to pull the wire through the die is greatly reduced because of the very large acceleration produced between the wire and the surface of the die, thereby reducing the power requirements and breakage of wire of smaller sizes. It is also claimed that an improved surface is produced on the wire and that the life of the die is increased. The method is shown diagrammatically in Figure 4.

The basic features of the apparatus include a nickel tube T centrally supported, having a die at its forward end and a counterweight at its rearward end. The raw wire is continuously fed to the die, and tension is applied to pull the wire through the die. The tube T serves as a feed-back of a magnetostrictive power oscillator. The length of the tube is one-half the wave length of the vibration, its center being a nodal point of the waves set up in the tube by the driving coil C^1. The pickup coil C^2 of the power oscillator is mounted between the central support and the rearward end of the tube. The nickel tube is slit at 32 in order to reduce eddy currents. Lubricant may be supplied the die by means described in the patent.

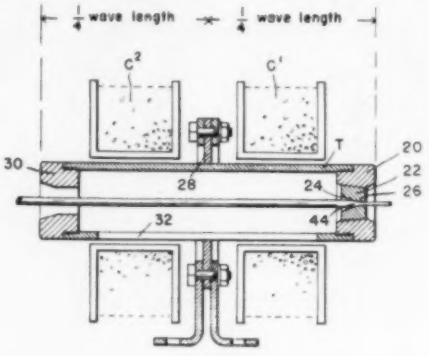


Figure 4

PLUG-HANDLING MECHANISM FOR SEAMLESS TUBE MILLS

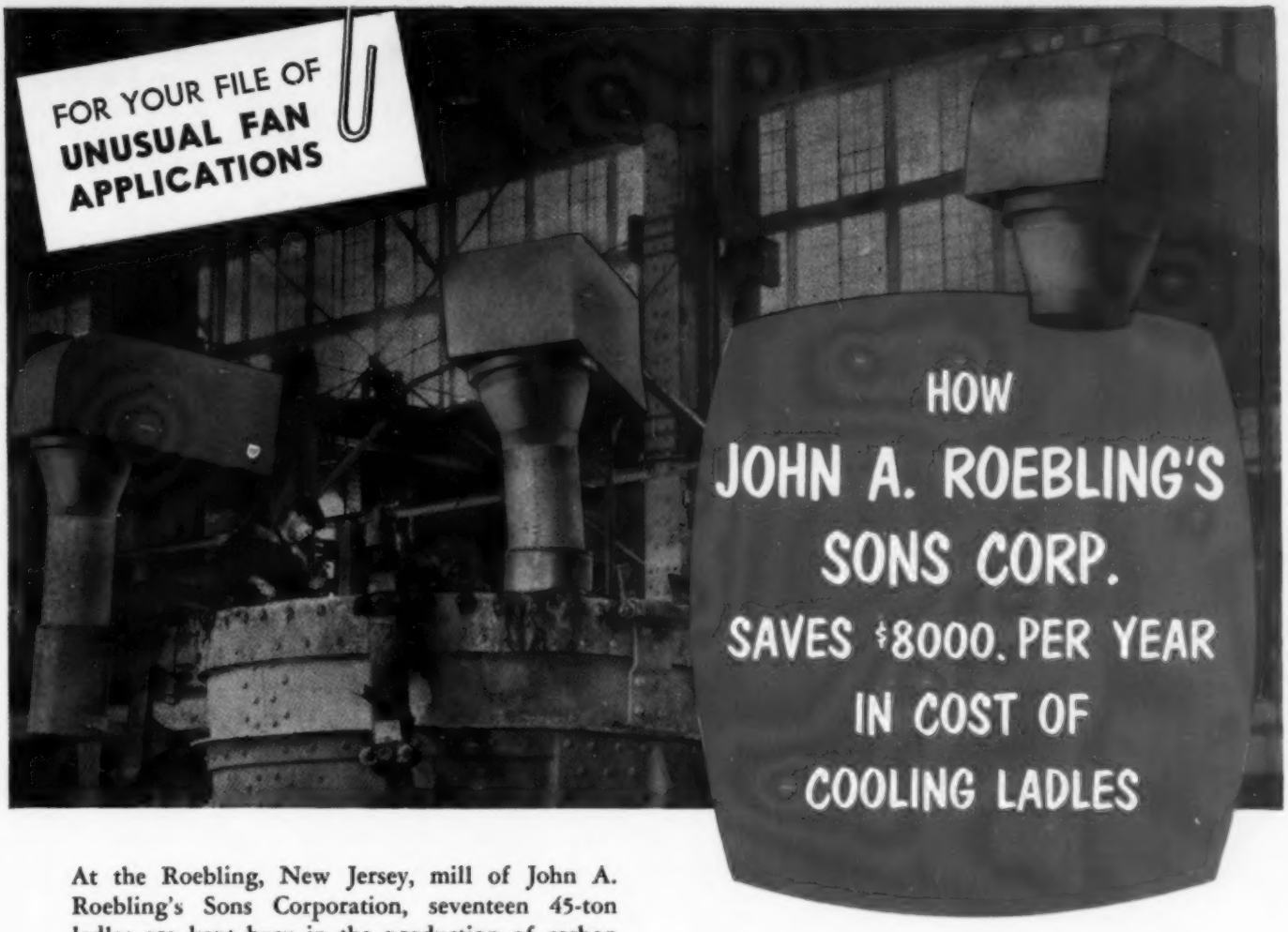
U. S. 2,635,492, issued April 21, 1953 to Martin S. Gettig, relates to seamless tube mills, in particular to the two-high or plug mill in which pierced billets are rolled after being expanded and drawn out in a Mannesman mill, to bring them to final shape, size, and wall thickness. The invention concerns a mechanism for placing a plug on the end of the mandrel and for removing it, and to a roll for supporting the mandrel to keep it properly centered relative to the pass between the mill rolls. The inventor claims the following advantages: simplicity of construction, ease of operation, ability to handle plugs satisfactorily without the strenuous labor normally required and without interfering with the normal operation of the mill.

RING ROLLING MILL

U. S. 2,636,406, issued April 28, 1953 to Frank Sidney Salter and assigned to the Loewy Engineering

OTHER PATENTS OF INTEREST TO THE IRON AND STEEL ENGINEER

Patent No.	Date	Subject	Inventor or Assignee
2,635,573	4/21/53	Pipe welding machine	Sacramento Pipe Works
2,635,875	4/21/53	Reciprocating feeder for sheet metal	United States Steel Corp.
2,635,957	4/21/53	Reduction of iron ore with hydrogen and carbon monoxide	Stora Kopparbergs Bergslags Aktiebolaget
2,636,009	4/21/53	Improving metal surface condition in acid pickling	Joseph T. Irwin
2,636,350	4/28/53	Impact forging	Chambersburg Engineering Co.
2,636,594	4/28/53	Procedure and apparatus for metal drawing	Wallace E. Kerr
2,636,604	4/28/53	Flotation of pyrites from a pyrite ore pulp	Bethlehem Steel Corp.
2,636,606	4/28/53	Apparatus for charging rectangular shaft furnaces	Arthur G. McKee & Co.
2,636,725	4/28/53	Flame hardening apparatus	Manley R. Nelson and Richard S. Sheehan
2,636,736	4/28/53	Apparatus for piling sheets for use in tin plate classifiers	The Aetna-Standard Engineering Co.
2,637,394	5/ 5/53	Cutting metal sheets of accurate length length from long strips	Nichols Wire and Steel Co.
2,637,685	5/ 5/53	Coke oven construction	Societe de Technique Industrielle
2,637,883	5/12/53	Ladle tipping mechanism	Edmund F. Schulze
2,637,896	5/12/53	Manganese alloy coating on steel strip	John Simon Nachtman
2,638,141	5/12/53	Sheet metal bending brake	A. V. Roe Canada Ltd.
2,638,143	5/12/53	Roller leveler for flattening and straightening sheet or strip	Frederick K. Maust
2,638,234	5/12/53	Feeding metal sheets or plates onto a conveyor	Armco Steel Corp.
2,638,334	5/12/53	Soaking pit furnace	John F. R. Jones
2,638,337	5/12/53	Quench block	Julius Harasty



At the Roebling, New Jersey, mill of John A. Roebling's Sons Corporation, seventeen 45-ton ladles are kept busy in the production of carbon steel, from which the famous Roebling wire rope is made. After each heat, ladles must be cooled down from 2000° F and pouring nozzles installed.

Dissatisfied with the old method of using compressed air for cooling ladles, engineers at Roebling's conceived the idea of trying a DeBothezat "Hy-V" Air Jet to do the job. They selected a "Hy-V" Air Jet with 21" fan wheel and 1½ HP motor which produces 5600 CFM at a nozzle velocity of 4570 FPM, and it worked so well that Roebling has installed four more. Each is mounted on a swinging bracket and is equipped with special nozzle extension so that air is discharged near the bottom of the ladle. Nozzle extension is retractable.

Here's what E. M. Yard, Roebling Combustion Engineer, has to say about the installation: *"Nearly the full capacity of one 200 HP air compressor was previously used to do this job. The use of "Hy-V" Air Jets means a power saving of probably $8,000.00 per year. In addition, the installation of these fan units, at a total cost of about $4,000.00 eliminated the need for additional air compressor capacity which would have cost $16,000.00. These fan units will recover their cost in about six months from power savings alone."*

Whether it's a question of cooling people or equipment, "Hy-V" Air Jets do the job efficiently and inexpensively. For detailed information, ask your DeBothezat representative or write our factory, Dept. IS-853 for catalog PE-753.

Certified Ratings
PFMA

"HY-V" AIR JET
is a 14-blade axial-flow pressure fan which projects a high velocity stream of air as far as 65 feet. Built with fan wheels 18" through 30" in diameter, with nozzle velocities up to 5780 FPM.

DeBothezat Fans

Division of American Machine and Metals, Inc.
EAST MOLINE, ILLINOIS

Co., Ltd., relates to ring rolling mills in which the wall thickness of annular blanks is reduced and their diameter increased by the combined action of an outer and an inner working roll. The patent describes grinding means which are held against the blank by hydraulic pressure which is automatically controlled in such a way that the guide means recede at the same rate as the expansion of the blank.

APPARATUS FOR CONTINUOUSLY GAUGING AND CLASSIFYING SHEET METAL FOR FLATNESS

U. S. 2,636,603, issued April 28, 1953 to Daniel E. Feick and Roy E. Howell, and assigned to United States Steel Corp. discloses a method for continuously gauging the flatness of rolled sheet metal. The essential features of the invention involve a support for the sheets providing a flat reference surface, a conveyor for moving the sheets over this surface, means for directing a light beam across the top of the sheet from one side to the other, and a photoelectric cell to pick up the light beam on the other side of the sheet.

REMOVING SURFACE DEFECTS BEFORE ROLLING

In U. S. 2,637,667, issued May 5, 1953 to William Oakley Binder, assigned to Union Carbide & Carbon Corp., a method of removing surface imperfections (such as seams, scabs, and blowholes) from steel preparatory to rolling is described.

The steel is heated to a temperature of about 1000 C and is exposed to a gaseous sulfur compound such as hydrogen sulfide. During this treatment, the metal is attacked and a loose scale forms on the surface. This scale can easily be removed by chipping or sandblasting, leaving a smooth surface relatively free of imperfections. In some cases, an inner scale is also formed. This scale may be removed by repeating the exposure to hydrogen sulfide at 800 C, after which sandblasting will remove this scale.

REDUCTION OF IRON ORE WITH HYDROGEN IN A FLUIDIZED BED

Pig iron can be produced from iron ore by a novel continuous process invented by Warren K. Lewis. The patent, U. S. 2,638,414, was issued May 12, 1953, and assigned to Standard Oil Development Co. Natural gas is decomposed by heating into hydrogen and carbon. The hydrogen reduces the finely divided iron ore by countercurrent flow through a fluidized bed reactor. The reduced iron-gangue mixture is then melted in a separate furnace, into which the carbon is added as fuel. Preheated air (heated in regenerators) is used in this furnace. Molten slag and pig iron are removed from this furnace.

Choose the men in your department now who will attend the . . .

1953 ANNUAL CONVENTION

OF THE

ASSOCIATION OF IRON AND STEEL ENGINEERS

HOTEL WILLIAM PENN

PITTSBURGH, PA.

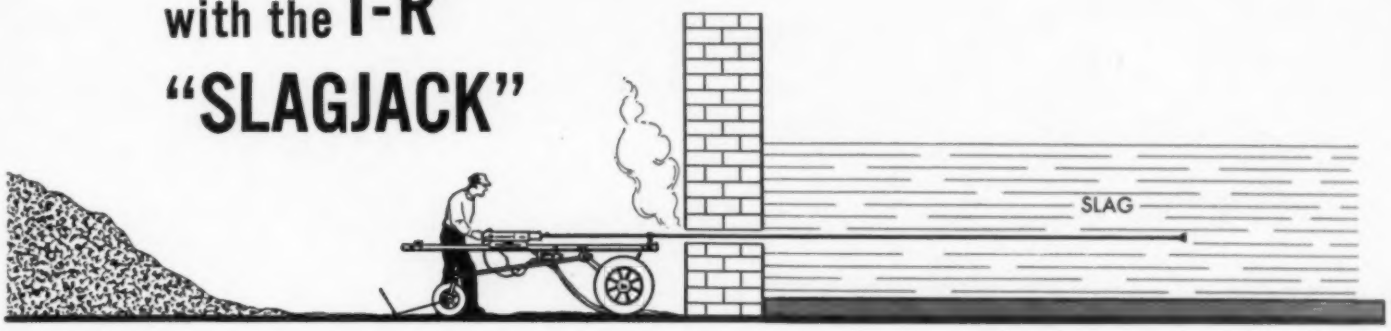
SEPTEMBER 28, 29, 30, OCTOBER 1

Make hotel reservations today!

SAVE HUNDREDS OF MAN HOURS

on open hearth repairs

with the I-R "SLAGJACK"



Here's a slag-drilling outfit that has repeatedly proved its ability to cut slag removal time by days! With the I-R "Slagjack," you can drill through the bulkhead and into the red hot slag pocket while the furnace is still in operation. No cooling or waiting period needed. When the furnace is shut down, you're all ready to blast—with greater safety and better fragmentation, too.

The "Slagjack" consists of an Ingersoll-Rand JHM mobile drilling unit, perfected water swivel and Carset Jackbits that can withstand the terrific thermal stresses of drilling through red hot slag. The water swivel assures an abundant supply of cooling water at the cutting face, by introducing water directly into the drill steel at maximum pressure.

You will also find the "Slagjack" ideal for general plant maintenance and demolition. It will tear out blast furnace linings or drill for shooting the fused bottom blocks under the salamander. Your I-R representative will be glad to give you the complete story—on the "Slagjack," or any other I-R equipment for steel mill maintenance.

I-R "Slagjack" in operation, drilling through brick bulkhead directly into red hot slag pocket of an open hearth furnace.

OTHER TIME-SAVING I-R TOOLS FOR STEEL MILL MAINTENANCE

Jackhamers

Portable Compressors

Paving Breakers

Carset Jackbits

Paving Breaker Steels

950-5

Ingersoll-Rand

11 Broadway, New York 4, N. Y.

NEVER BEFORE

anything like this on stripper cranes

- **Special electrical counterweight (counter torque device developed by The Alliance Machine Company, prevents ingots from falling, inflicting damage to buggies and also automatically prevents slack cable during stripping operation.)**
- **Eliminates heavy, hazardous counterweights.**
- **Due to a unique lubricating device, the ample size bronze nut gives many years of trouble-free service.**
- **All gears are enclosed and run in oil.**
- **Cab provides operator with maximum visibility and safety.**

There are many reasons why it pays to consult Alliance when you are planning to install material-handling equipment. Over half a century of experience building cranes and mill machinery is always at your disposal.

World's Largest Builders of World's Largest Cranes

LADLE CRANES · GANTRY CRANES · FORGING MANIPULATORS · SOAKING PIT CRANES
STRIPPER CRANES · SLAB AND BILLET CHARGING MACHINES · OPEN HEARTH CHARGING MACHINES · SPECIAL MILL MACHINERY · STRUCTURAL FABRICATION · COKE PUSHERS

THE ALLIANCE MACHINE COMPANY

Main Office, ALLIANCE, OHIO · Pittsburgh Office, 1622 OLIVER BLDG., PITTSBURGH, PA.

Alliance

POOLE

A COPY OF CATALOG GIVING FULL DESCRIPTION AND ENGINEERING DATA SENT UPON REQUEST.

FLEXIBLE COUPLINGS

POOLE FOUNDRY & MACHINE COMPANY

WOODBERRY, BALTIMORE, MD.

Cut wire fence re-coating costs!

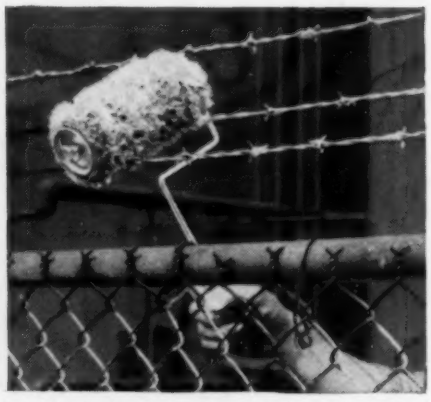
Users Report Savings of 30% to 40% With Rust-Oleum Extra-Long Nap Lamb's Wool Roller!

Special roller glides easily over wire sections. (Rusted sections have already been primed with Rust-Oleum 769 Damp-Proof Red Primer to Stop Rust.) Finish coat is Rust-Oleum 470 R.M. Aluminum.

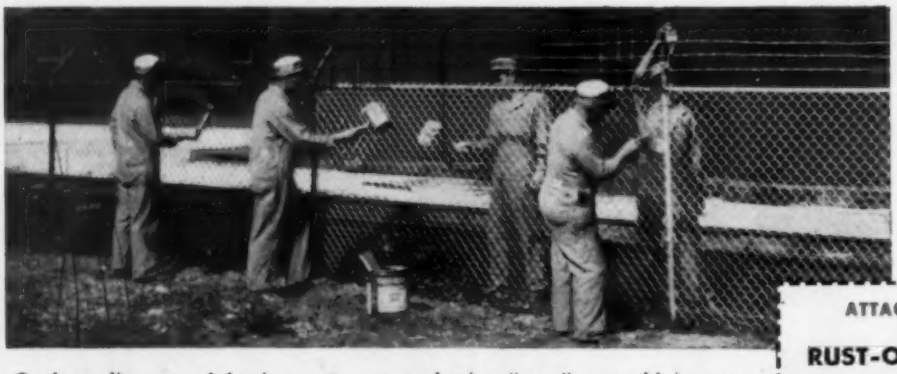
A *new, exclusive, different-type* roller! Greater diameter, specially selected skins, extra-long Lamb's Wool – all combine to give you more coverage faster and easier in the new Rust-Oleum Roller-Coating System.

Close-up shows how Extra-Long Nap Wool reaches around to coat approximately 70% of other side of fence at same time. Rust-Oleum's *exclusive* penetrating qualities saturate cross wire sections for desired mil thickness.

Man follows with "dry" roller on opposite side of fence to catch and use surplus "tears" and quickly coat remaining 30% of wire sections.



Even barbed wire sections can be roller-coated in one easy pass. 99% of the material is used on the fence – *not* on the workers, *not* on the ground.



On long distances of fencing, a 5 man production "team" can achieve even greater savings. The first man wirebrushes the surface to remove dirt, dust, rust scale, etc. The second man applies Rust-Oleum liberally by roller, coating the wire sections and barbed wire. The third man follows on the opposite side of the fence with a "dry" roller to catch and use the surplus. The fourth and fifth men work on opposite sides of the fence, brushing the pipe framework and the barbed wire arms. See how this new Rust-Oleum system can save you money. Attach coupon to your letterhead, mail *today*.

RUST-OLEUM®

STOPS RUST!

ATTACH TO YOUR LETTERHEAD—MAIL TODAY!

RUST-OLEUM CORPORATION
2443 Oakton Street, Evanston, Illinois

Please show us how your new Extra-Long Nap Lamb's Wool Roller will cut our wire fence re-coating costs. Include prices, complete literature about Rust-Oleum and nearest sources of supply. We have approximately _____ yards of wire fencing.

Positive interlock (optional)

Short lever travel

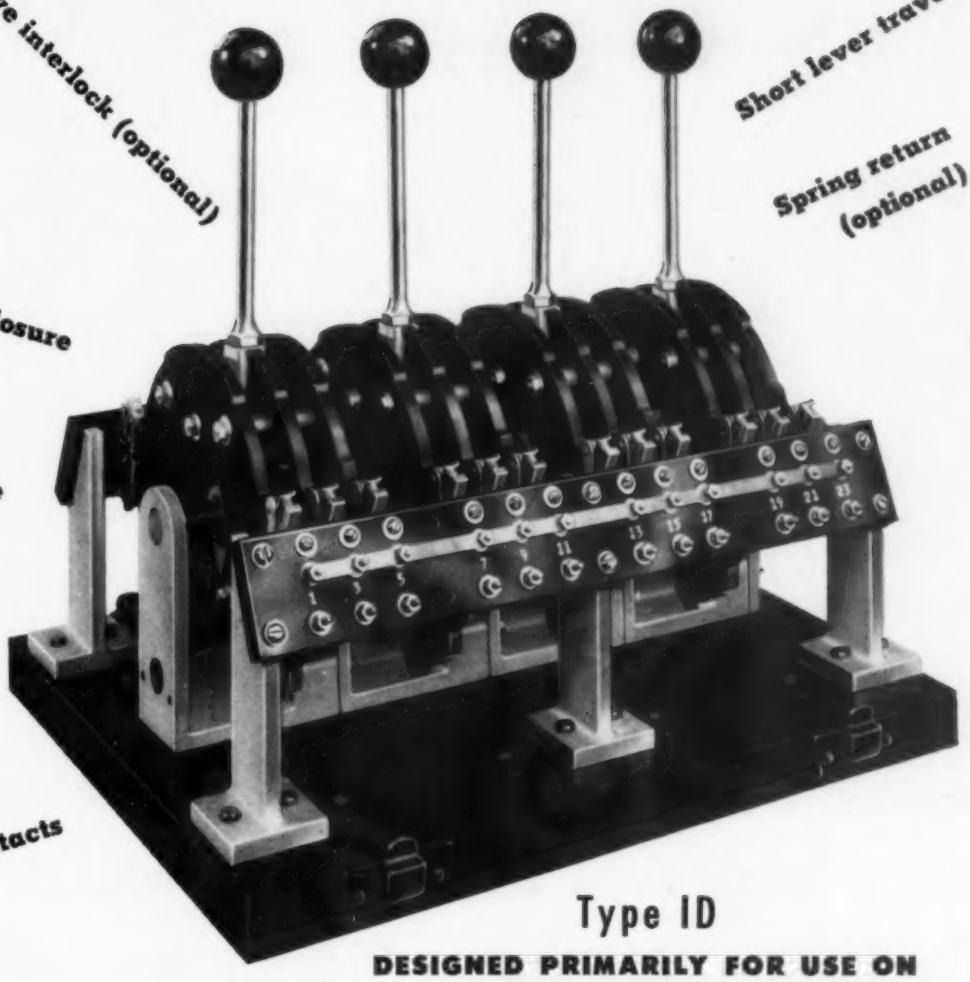
Spring return (optional)

Up to 4 switches in one enclosure

Handy to remove enclosure

Self-lubricating bearings

Fine silver double break contacts



Type ID

DESIGNED PRIMARILY FOR USE ON COKE OVEN PUSHER MACHINES

P-G master switches

Unique in design and pioneered by Post-Glover, this switch may contain up to four single Masters in one enclosure on one solid base, thereby greatly reducing longitudinal mounting space.

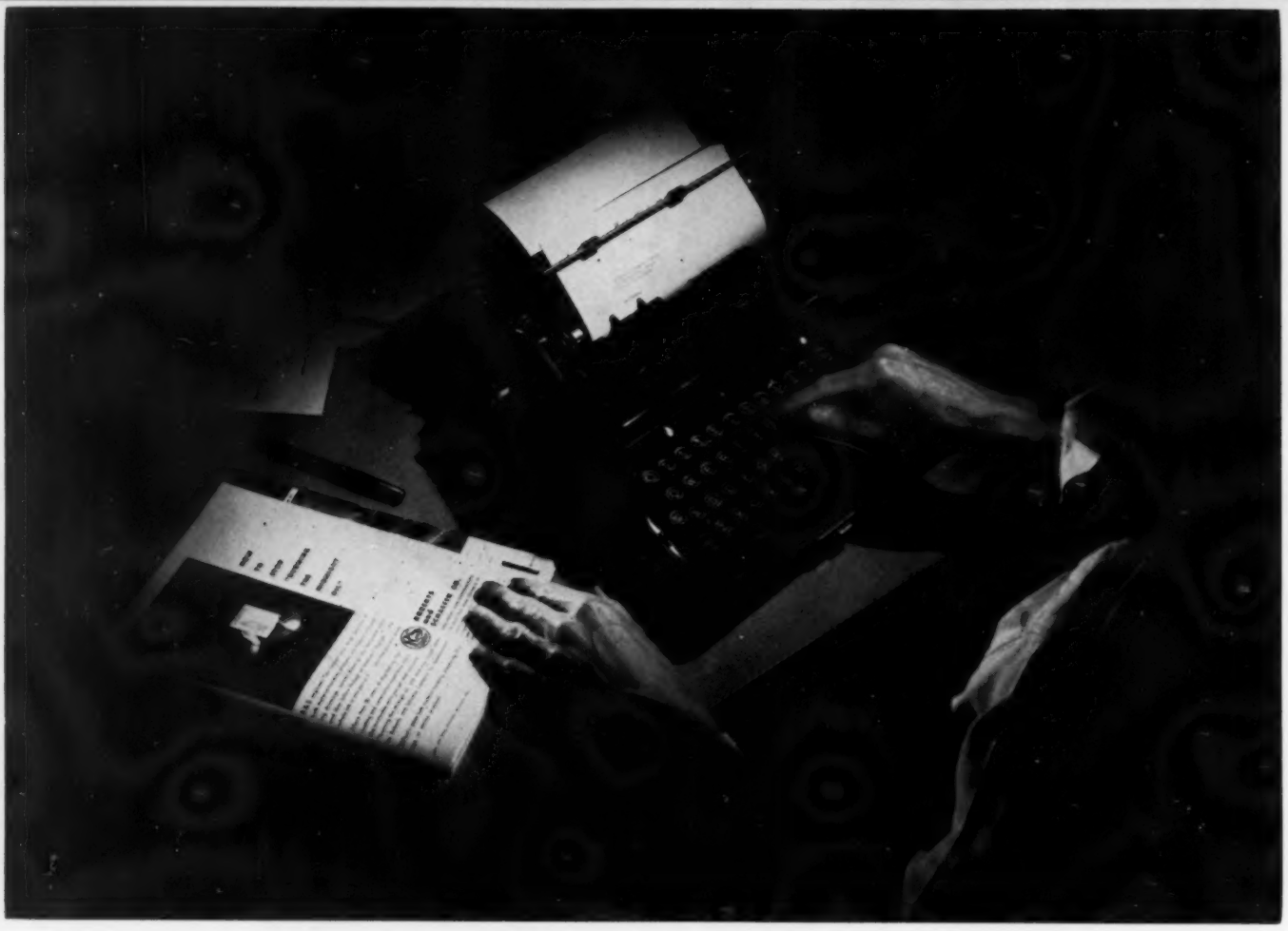
Simple, rugged and positive, the P-G patented mechanical interlock has proved in actual field service to be the answer to the coke plant engineer's request for more nearly fool-proof protection of operating equipment. It can be provided between any two or more adjacent single switches under one cover.

Write for Bulletin No. 400—Dept. E

THE POST-GLOVER ELECTRIC COMPANY

• ESTABLISHED 1892 •

221 WEST THIRD STREET, CINCINNATI 2, OHIO



A WISE STEP TOWARD SOLVING BULK - HANDLING - PROCESSING PROBLEMS

Write to R & S

Is there a bulk material that seems to defy all your efforts to handle or process it efficiently and economically? Call us in.

Training these hard-to-handle bulk materials is our business: coal, coke, coke breeze, sand, dolomite and what have you. For well over 50 years R&S engineers have been developing improved methods for handling these "problem items;" working with companies of every size — from big concerns well staffed with engineers to small firms with none.

We can come into the job at any point — right at the start, or go to work on preliminary plans; can convert rough sketches into finished drawings, convert the drawings into fabricated units, see the job through erection — the whole job or any part, as you decide.

This "working with R&S" has worked well for many, may easily provide the ideal solution you need. It's easy to explore — simply write a letter.

ROBERTS & SCHAEFER CO.
ENGINEERS AND CONTRACTORS
130 North Wells Street, Chicago 6, Ill.
HIBBING, MINN. (Box 675)
HUNTINGTON, W. VA.
NEW YORK 19, N. Y.
PITTSBURGH 22, PA.

R&S AND COMPANY

AJAX DIHEDRAL couplings

Cut line-up time to minutes...

And that means you cut high down-time costs. Exclusive Ajax Dihedral tooth shape takes care of necessary misalignment between driving and driven shafts.

Handle misalignment far beyond capacity of conventional flexible couplings.

Seals keep lubricant in and dirt out.

Write for full information.

features

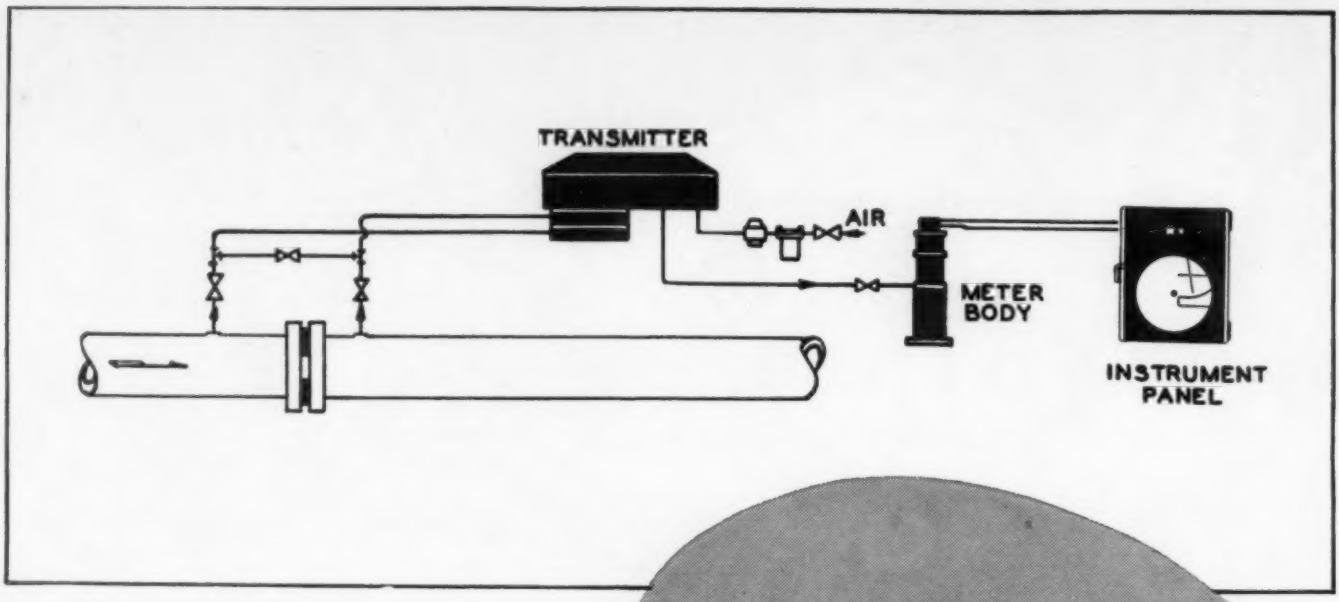
Least backlash

Most misalignment capacity

All gear teeth hardened to 50-55 Rockwell C

AJAX FLEXIBLE COUPLING CO. INC. • WESTFIELD, N. Y.

Representatives in Principal Cities



Republic Pneumatic Electric Metering System

DESIGNED ESPECIALLY for YOU Mr. Steelmaker to Measure Blast Furnace and Coke Oven Gas Flow

We had your problems in mind when we designed the Pneumatic Electric Flow Meter. We know a steel mill is a dusty place; it can't be otherwise and do a good job making steel. We know the gases produced in a steel mill are dirty. So, to help you steel mill people keep track of what is going on inside your maze of pipes, furnaces and ovens, we designed a meter that could operate in dusty surroundings and accurately measure flow of dirty gases without frequent maintenance. Yes, we engineered the dirt right out of the meter.

Here's How:

KEEPS DIRT OUT

The Pneumatic Electric Flow Meter uses a differential pressure transmitter to isolate dirty gases from direct contact with mercury in meter body. Transmitter establishes an air loading pressure that is directly proportional to flow differential. The measuring chamber of the transmitter is small and has practically no change in volume when differential pressure changes. Thus, dirt in the gas is not sucked into the chamber to cause the diaphragm to stick or clog.

DOUBLY DUST SEALED

Rugged boiler meter case completely encloses reading instruments which are individually sealed. Double seal prevents dirt from getting in to foul or clog parts and cause inaccuracies or failure.

REMOTE READING INSTRUMENTS

Meter body responds to air loading pressure changes from transmitter and produces proportional electrical variations which are transferred to remote reading instruments. Integrator and recorder operate independently — may be separated to suit individual requirements.

OVER-ALL ACCURACY

Differential pressure transmitter is extremely sensitive to pressure changes, however rapid. Mercury in meter body has no work to do, only makes or breaks contact with resistance rods. Recorder permanently records rate of flow and time of flow changes. Integrator working on modified watt-hour principle *continuously* totalizes all flow, not just average of spot readings. Accurately follows all sudden changes in flow.

RANGE EASILY CHANGED

Differential pressure transmitter and meter body can be adjusted (many times right in the field) for almost any range.

CONTINUOUS METERING

Measurement and control of fluid flow is not interrupted by meter failure because Pneumatic Electric Flow Meter is built to give dependable, maintenance-free service. Working mechanism is accessible and easy to adjust. And remember—Republic has 28 branch offices throughout the country, so there's one near you to help you with your metering and control service problems.

Pneumatic Electric Flow Meter is also excellent for metering widely varying flows such as occur in oxygen scarfing operations.

REPUBLIC FLOW METERS CO.

2240 Diversey Parkway, Chicago 47, Illinois

OKOLITE-OKOPRENE ELECTRICAL CABLE...

proved in the steel industry for long, trouble-free service

Only a cable specifically built to withstand the heat, moisture, oils, acids and abrasive conditions in steel mills can be installed with confidence in mill power circuits. Okolite-Okoprene cables are built that way, and have been proved for power and control wiring in mills throughout the U. S.

Their basic electrical insulation is Okolite, the moisture-resisting rubber compound being used so successfully on 35,000 volt submarine cables. Their outer protection is tough Okoprene that won't rot or deteriorate. This neoprene sheath withstands high temperatures and is highly resistant to chemicals, oils, flame, mechanical damage, and any degree of moisture.

Both sheath and insulation, applied by Okonite's famed strip process, are bonded together during vulcanization in a metal mold. Only Okonite uses this precision method of manufacture in regular production.

To provide extra insurance against circuit outages, Okolite-Okoprene cables are shipped out only after passing the most severe a-c and d-c tests used in the industry.

Your Okonite representative can show you how Okolite-Okoprene cables will add years of service to your power circuits. Call him in today; or write for Bulletin IS-1053. The Okonite Company, Passaic, N. J.

The best cable is your best policy

OKONITE OKONITE SINCE 1878 *insulated wires and cables*

9674

For a lead "pan" cinch...

it's THERMALLOY* to outlast cast iron by 479 days!

A large steel and wire company uses a double-lead patenting furnace to give good drawing qualities to wire. In this process, wire is drawn through a "lead" pan enclosed in the furnace where temperatures range from 1600 to 1650°F.

Previously, cast iron "lead" pans were used . . . and the furnace had to shut down nearly every 21 days because the pan burned out and needed replacement. Then, a Thermalloy "lead" pan with integrally cast sinkers was installed. *To date, this pan has over 500 days of service* . . . saving this company expensive hours of repair and down time.

This is just one example of how a Thermalloy heat-resistant casting has helped a manufacturer to realize more economy in heat-treating parts. Do you have a similar need for Thermalloy in retorts, furnace parts, trays, racks, pots or muffles? Call in an Electro-Alloys engineer for full information, or write Electro-Alloys Division, 4007 Taylor Street, Elyria, Ohio.

THERMALLOY "LEAD" PAN ADVANTAGES

- Resists air-line attack, scaling and oxidation.
- Higher strength prevents sagging and distortion.
- Less weight means easier installation and less maintenance of supporting arches.
- Greater resistance to abrasion.

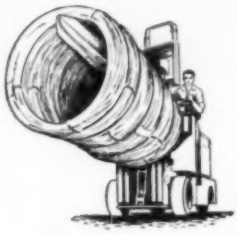
*Reg. U. S. Pat. Off.

AMERICAN Brake Shoe COMPANY

ELECTRO-ALLOYS DIVISION

ELYRIA, OHIO

For industrial trucks... Exide-Ironclad now offers



★ 20% more capacity in the same space

★ Lowest cost per A. H. to own and operate

These are the features that contribute to the higher capacity and longer life of the T-H Battery:

Its larger positive plates, containing corrosion-resistant Silvium, are different . . . unique . . . exclusive! No other type of positive plate construction offers you the advantages of the T-H Exide-Ironclad, with its slotted plastic tubes, permanently sealed on the bottom with polyethylene tube sealer. More active material is exposed to the electrolyte, resulting in greater power. More active material is retained, providing higher battery capacity for a longer working life.

Other features include improved negative plates . . . practically indestructible Pormax separators . . . new sealing compound . . . shockproof molded jar . . . unbreakable quarter-turn vent plugs of plastic . . . corrosion-resistant tray coating.

Now-more than ever before...
YOUR BEST POWER BUY AT ANY PRICE!

1888 . . . DEPENDABLE BATTERIES FOR 65 YEARS . . . 1953

The new T-H
Exide-Ironclad
BATTERY

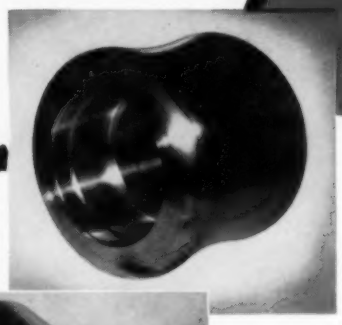
Thrifty Hauler

THE ELECTRIC STORAGE BATTERY COMPANY, Philadelphia 2 • *Exide Batteries of Canada, Limited, Toronto*
"EXIDE", "EXIDE-IRONCLAD", "SILVIUM", "PORMAX", *Reg. T.M. U.S. Pat. Off.*

If your wear problem is listed here...

STOODY CASTINGS can help you!

JOURNALS
SLEEVES
BEARINGS
BUSHINGS
GUIDE ROLLS
FORMING ROLLS
STRAIGHTENING ROLLS
SIDE ROLLS
ETC.



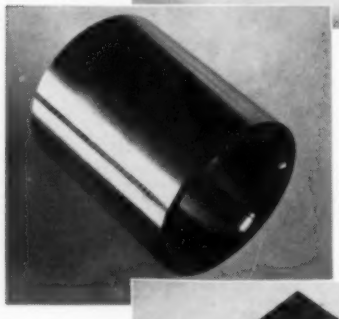
Steel Mill Idler Roll for Straightening Machine

Why suffer production losses and unnecessary expense from equipment wear and constant replacements? Now, the ultimate answer to longer performance is available—in STOODY Centrifugal Castings!

Made from specially alloyed metals, Stoody Castings satisfy innumerable requirements: *Outstanding resistance to abrasive wear, heat and corrosion; high impact strength; extremely dense grain structure and freedom from inclusions of all types!*

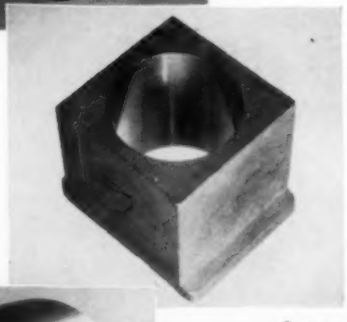
Stoody Castings are individually made for your specific use. All castings may be machined to necessary tolerances and satiny smoothness.

Although premium priced, Stoody Castings still show remarkable savings . . . long runs without downtime, healthy increases in overall production, relative freedom from replacements!

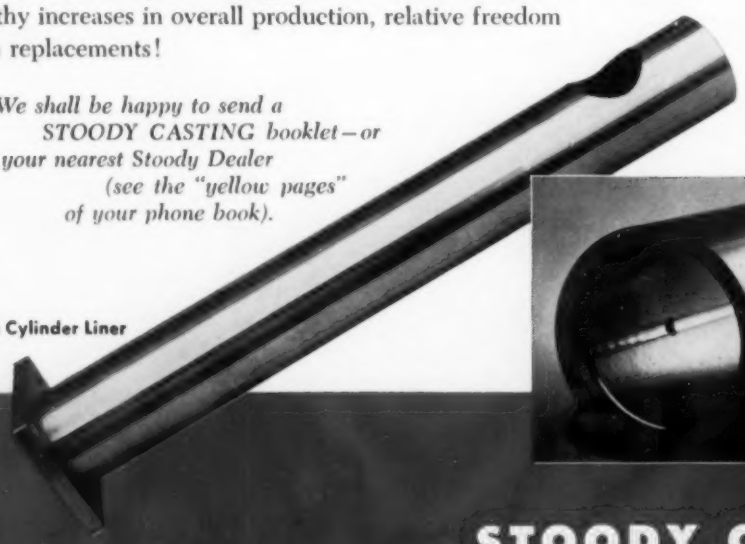


Tin Mill Bushing

We shall be happy to send a STOODY CASTING booklet—or ask your nearest Stoody Dealer (see the "yellow pages" of your phone book).



Square Bearing Box



Extrusion Cylinder Liner

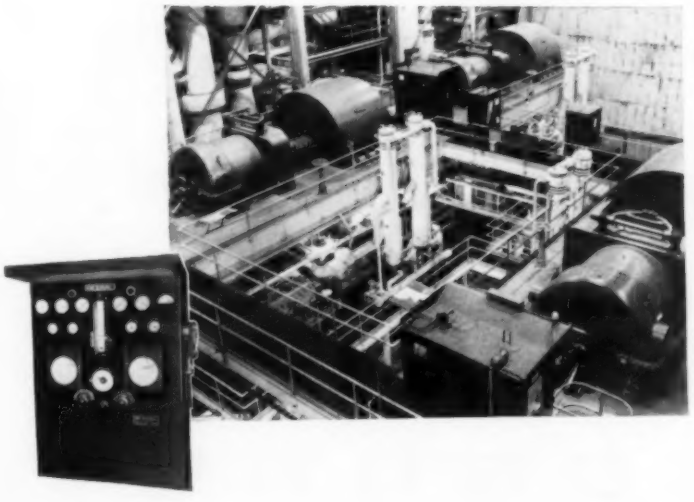
Bearing Bushing with Oil Grooves

STOODY COMPANY

11942 East Slauson Avenue, Whittier, California

ALL BUT ONE OF THE BLAST FURNACE BLOWER INSTALLATIONS IN THE UNITED STATES SINCE 1940 ARE ASKANIA CONTROLLED

The installation below: De Laval turbo-blowers at United States Steel Corporation's Gary Steel Works — Askania-controlled.



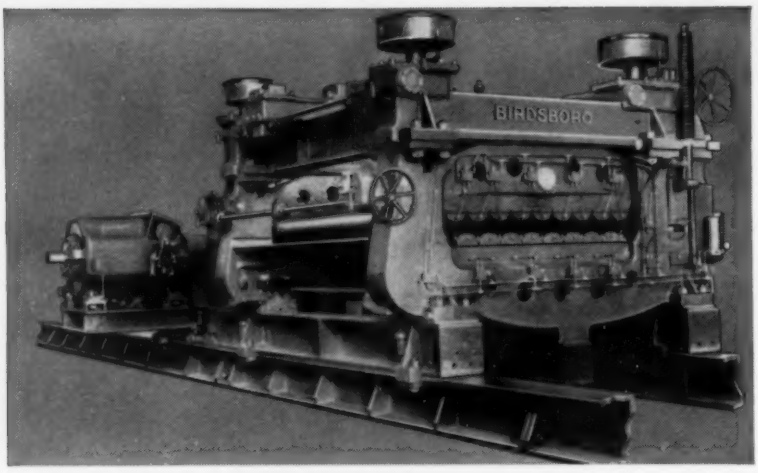
This spectacular record should be no surprise to steel men. They know that it is solidly based on Askania's performance. Simple, rugged controls . . built for continuous duty under the most severe operating conditions. The Askania Jet-Pipe Principle makes them the simplest effective automatic control equipment.

Consult Askania's specialists for information on Askania controls for a variety of pressure, flow, and proportioning applications. Bulletin 139 gives details.

ASKANIA REGULATOR COMPANY

246 E. Ontario Street, Chicago 11, Illinois

Subsidiary of General Precision Equipment Corp.



Leveling machine for hot carbon plate 3/16" to 1/2" x 100" wide.

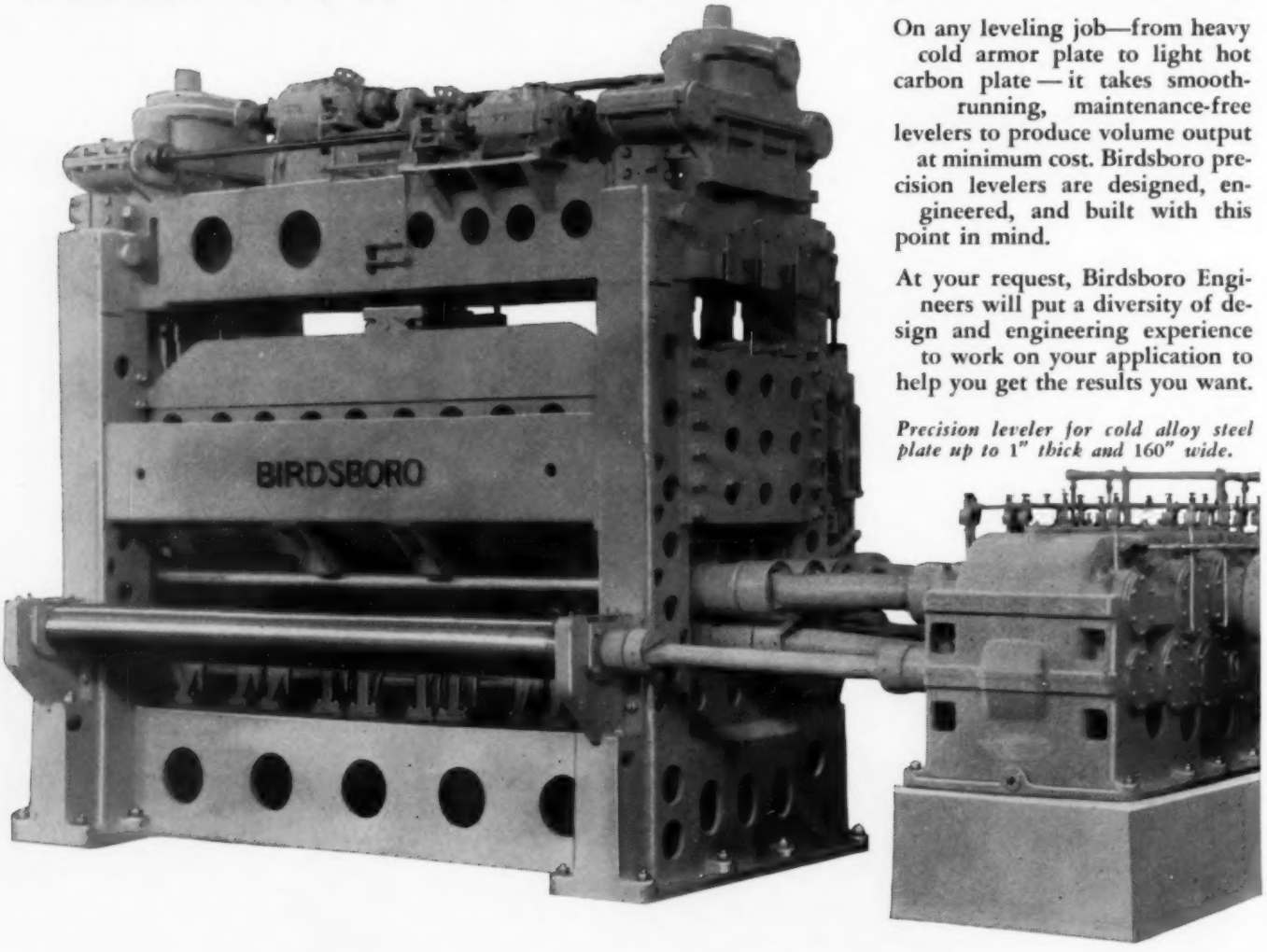
STEP UP YOUR OUTPUT -- cut down your costs

BIRDSBORO LEVELING MACHINES

On any leveling job—from heavy cold armor plate to light hot carbon plate — it takes smooth-running, maintenance-free levelers to produce volume output at minimum cost. Birdsboro precision levelers are designed, engineered, and built with this point in mind.

At your request, Birdsboro Engineers will put a diversity of design and engineering experience to work on your application to help you get the results you want.

Precision leveler for cold alloy steel plate up to 1" thick and 160" wide.



BIRDSBORO

BIRDSBORO STEEL FOUNDRY & MACHINE CO., BIRDSBORO, PENNA. **STEEL MILL MACHINERY** Offices in Birdsboro, Pa. and Pittsburgh, Pa.

•***designers and builders of:*** Steel Mill Machinery • Hydraulic Presses • Crushing Machinery • Rolls • Special Machinery • Steel Castings

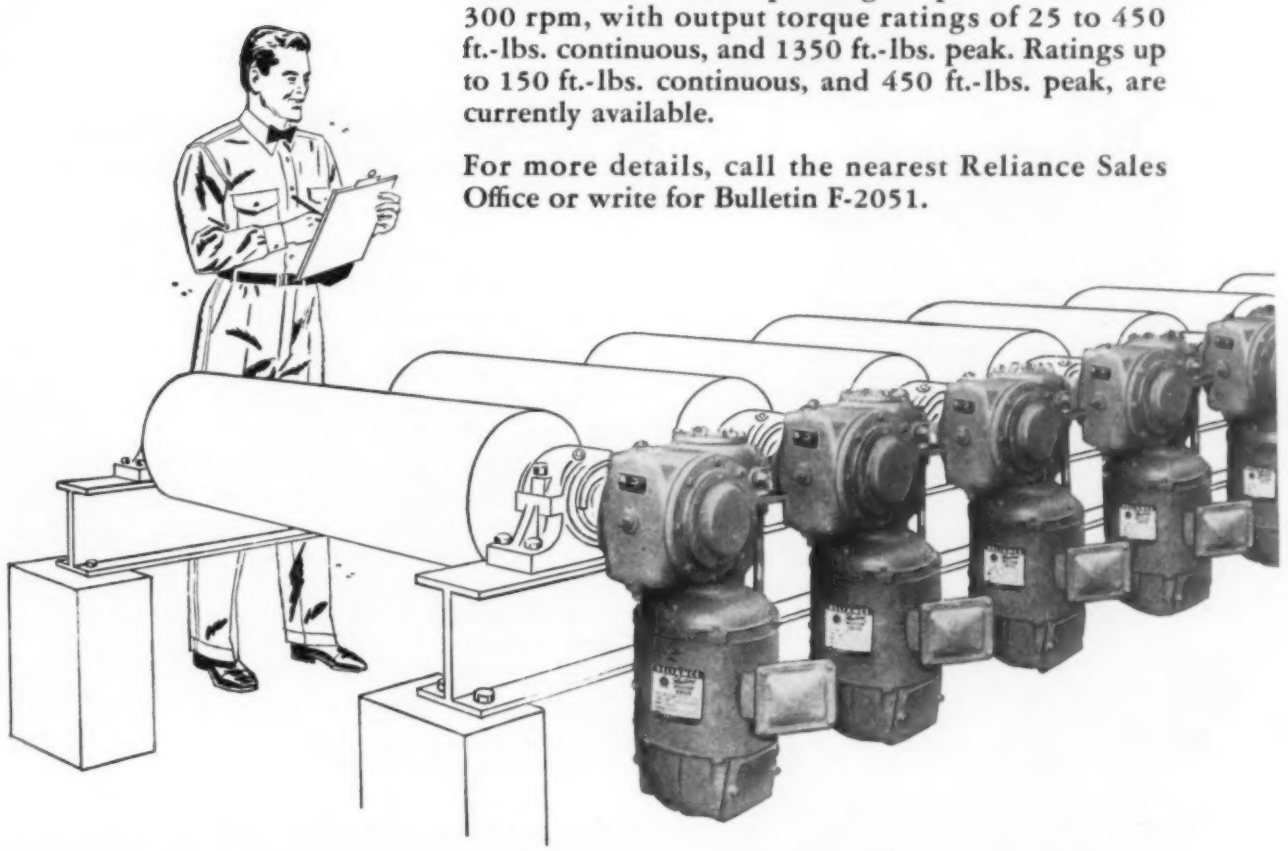
MM-28-52-R

NOW... HIGH-TORQUE, LOW-SPEED Trouble-Free Roller-Table Operation WITH RELIANCE Floating Worm Gearmotor Drive

Mounted directly on the roller shaft . . . the Reliance Floating Worm Gearmotor enables roller tables to operate continuously, unaffected by roll warpage or misalignment. External gears and couplings and heavy foundations are no longer required.

The Floating Worm Gearmotor meets requirements for a-c. or d-c. drives operating at speeds from 25 to 300 rpm, with output torque ratings of 25 to 450 ft.-lbs. continuous, and 1350 ft.-lbs. peak. Ratings up to 150 ft.-lbs. continuous, and 450 ft.-lbs. peak, are currently available.

For more details, call the nearest Reliance Sales Office or write for Bulletin F-2051.



RELIANCE ELECTRIC AND ENGINEERING CO.

1084 Ivanhoe Road, Cleveland 10, Ohio • *Sales Representatives in Principal Cities*

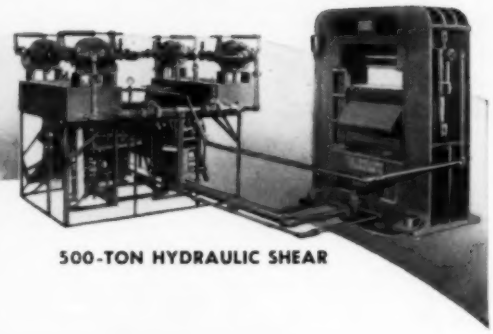
STEEL MILL *EQUIPMENT*

Precision built

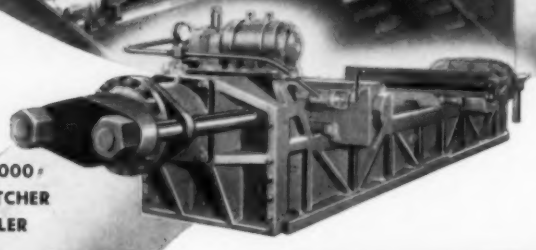
BY

F&Y

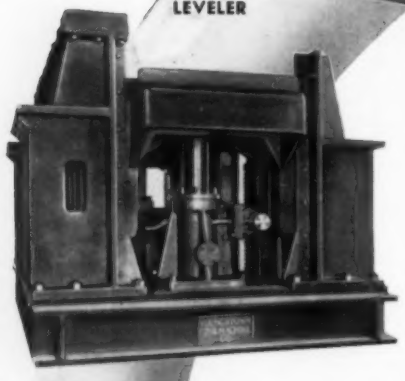
100" SCRUBBER LINE



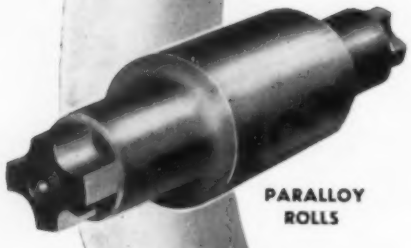
500-TON HYDRAULIC SHEAR



800,000# STRETCHER LEVELER



SLAB PILER



PARALLOY ROLLS

Check this List for the Products You Need

- PARALLOY ROLLS (Pinch, Coiler, Tension, Steel Mill)
- HYDRAULIC SLAB AND BILLET PILERS
- STRIP AND SHEET OILING EQUIPMENT
- SHEET SCRUBBER AND CLEANING LINES
- HOT SAWS—ROCKING AND SLIDE TYPES
- HOT BEDS—COOLING BEDS—TRANSFERS
- BILLET EJECTORS—PINCH ROLL STANDS
- SLITTERS—SPECIAL SHEARS AND GAUGES
- TILTING TABLES—Traveling and Lifting Tables
- Continuous PICKLING Lines—ROLLER LEVELERS
- FURNACE Charging Equipment—Furnace Pushers
- Strip Steel COILERS and REELS—SCRAP BALLERS
- RAILROAD Spike Forming Machines—ROLL LATHES
- Sheet GALVANIZING Lines—Wire Patenting Frames
- Stretcher Levelers—Angle and Shape Straighteners
- Rolling Mill Tables—Gear and Individual Motor Types
- DUCTILE CASTINGS (80,000 PSI.)

Machinery Built to Customer's Design and Detail Drawings

The Youngstown Foundry & Machine Co.

OVER SIXTY YEARS OF SERVICE TO THE STEEL INDUSTRY

Youngstown, Ohio

NATIONAL SA-SERIES MOTOR AND GENERATOR BRUSHES

TRADE-MARK

"NATIONAL" SA-series brushes were developed especially to provide a higher degree of uniformity in operation than was ever before achieved over a broad field of machines and service conditions. These brushes offer very closely controlled commutation characteristics and permit, with relatively few grades, a highly accurate, efficient brush application technique.

Many years of successful service, on all kinds of equipment and under widely divergent conditions, have *proved* the ability of this brush family to fulfill its objectives. Today, largely because of experience with the SA-series, electrical and maintenance men have come to expect . . . and they *get* . . . much more for their brush dollar all through the mill.

SA-35... has both *good commutating ability* and *long life* for a wide range of motors and generators where heavy loads and high surface speeds are combined with normal commutating conditions.

SA-3538... similar to SA-35 in load-carrying ability and commutation factor, but with distinctly different film-forming characteristics designed to prevent streaking and threading of the commutator under low average-load conditions.

SA-45... unequalled for *ridability at high speeds* and *peak commutating performance;* especially adapted to extremely severe commutating conditions on the most difficult jobs.

It pays to know your "National" brush grades . . . and to look for them under the "National" trademark on every brush you use.

HOW GOOD IS REALLY GOOD BRUSH PERFORMANCE? Write National Carbon Company

The term "National", the Three Pyramids device, and the Silver Colored Cable Strand are registered trade-marks of Union Carbide and Carbon Corporation

NATIONAL CARBON COMPANY
A Division of Union Carbide and Carbon Corporation
30 East 42nd Street, New York 17, N. Y.

District Sales Offices:
Atlanta, Chicago, Dallas, Kansas City, New York, Pittsburgh, San Francisco

In Canada: NATIONAL CARBON LIMITED
Montreal, Toronto, Winnipeg

NATIONAL STANDARDIZED BRUSHES
BETTER— PRODUCT—PACKAGE—PRICE— FASTER

The Coupling that gives you these 7 Design Features

1 **ALL STEEL** construction from high grade steel castings with fine tool finished surfaces.

2 **ONE PIECE COVER SLEEVE** is one solid forged steel unit for added safety at high speeds.

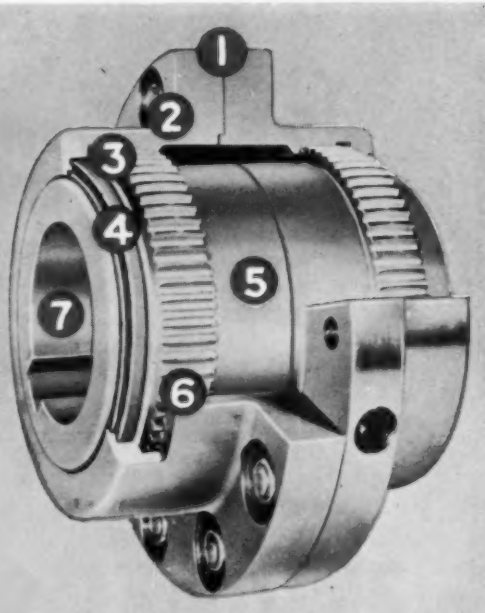
3 **AUTOMATIC LUBRICATION** with ever-present oil film between hub and sleeve to prevent friction or wear.

4 **POSITIVE SEAL** hermetically seals coupling against oil oxidation and keeps ample supply of CLEAN oil inside.

5 **LONGER LINING UP SURFACE** insures easy, accurate initial alignment and full capacity to handle any subsequent misalignments.

6 **COVER SLEEVE BEARING** prevents any added pressure to either shaft; eliminates adverse end crank action on shaft.

7 **LARGER BORE** permits use of smaller physical capacity for same size shaft and reduces rotating weight.



WALDRON GEAR TYPE COUPLING

most economical to buy and to use!

- ✓ Available in Standard, Heavy Duty Mill, Mill Motor, Floating Shaft, Jordan, Shear Pin, Cut-Out, Vertical Floating Shaft and Spacer types. A type and size for every purpose.
- ✓ Standard design can be quickly and easily adapted for any special application.
- ✓ Waldron nylon non-corrosive, non-lubricated gear coupling for small fractional H.P drives. Nothing to wear out. No maintenance.

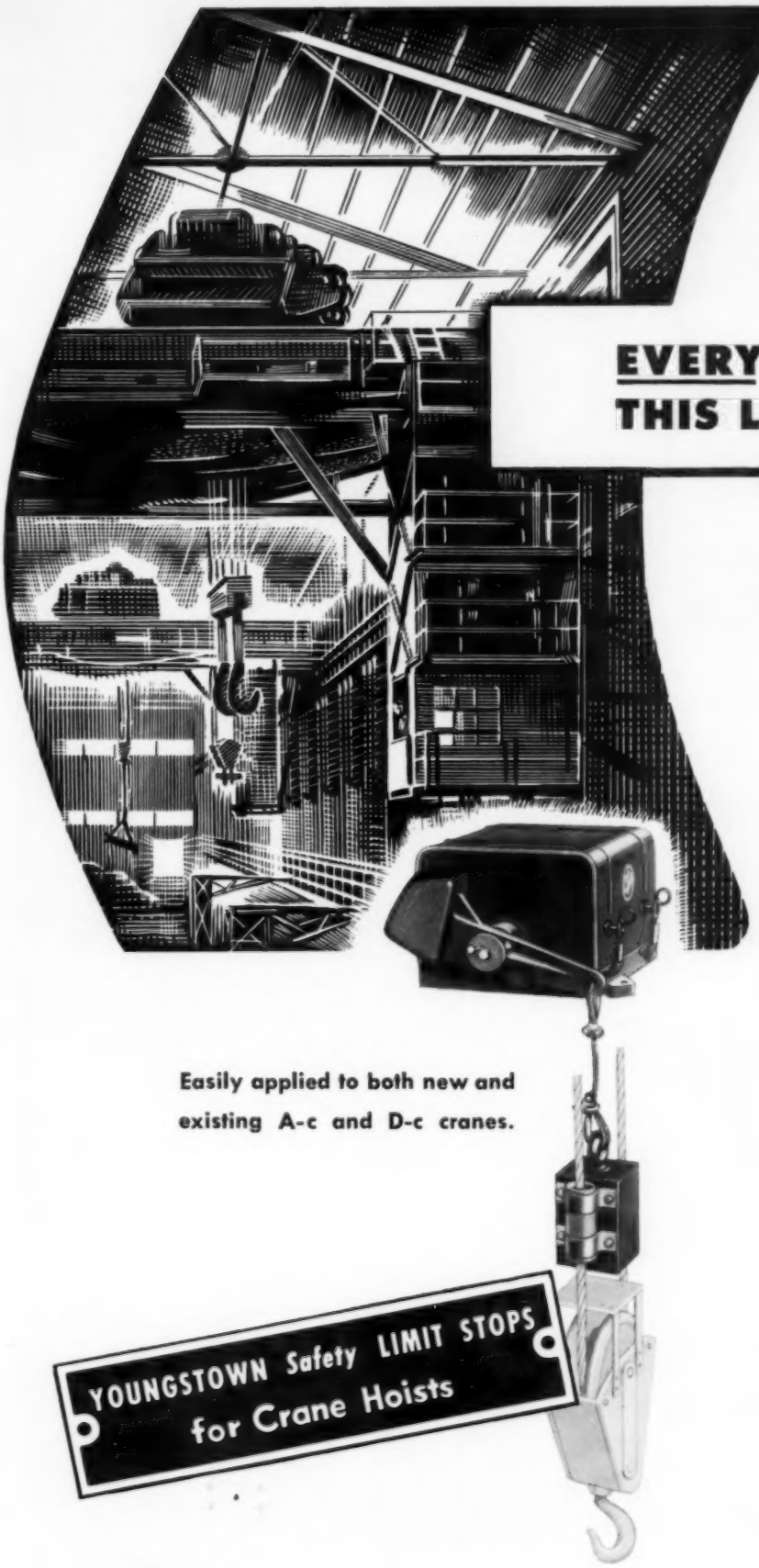
Its design refinements, rugged construction and operating advantages account for the notable performance records of the WALDRON Gear Coupling. Its reputation for providing a longer life of trouble-free service has for many years made it the first choice of practically all leading equipment builders. When you specify WALDRON you are getting maximum protection against coupling failure, costly shut-downs and replacements and damage to expensive equipment. Write for Catalog 57.

JOHN WALDRON CORPORATION

Waldron Series "A" and Junior Gear Couplings · Francke Pin Type Coupling · Anchor-Waldron Overload Cut-Outs

NEW BRUNSWICK • NEW JERSEY

Sales Representatives In Principal Cities • In Canada—Peacock Brothers, Ltd.



EVERY CRANE* NEEDS THIS LIMIT STOP

Not only disconnects the motor from the line, but stops the motor quickly. On D-c cranes, where high hoisting speeds prevail, dynamic braking aids in bringing the hook block to rest.

These Limit Stops are operated directly by the hook block, hence stretching of the hoisting cables does not affect the tripping point. By removing the fear of an over-hoisting accident, the YOUNGSTOWN Limit Stop enables the crane operator to do better work.

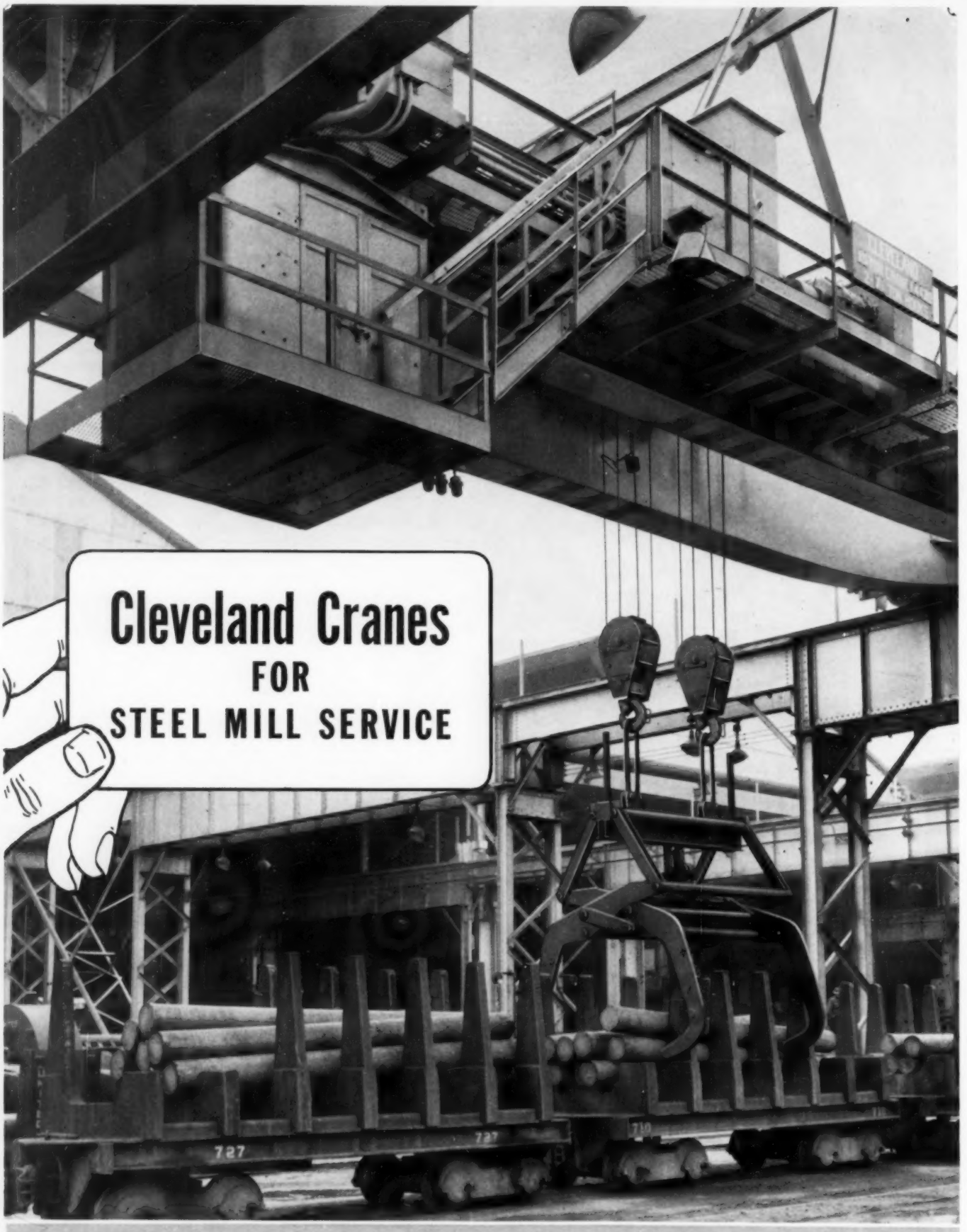
Easily applied to both new and existing A-c and D-c cranes.

YOUNGSTOWN Safety LIMIT STOPS for Crane Hoists

* A crane *without* a Youngstown is as risky as a boiler *without* a safety valve.

Ask for Bulletin 1032 describing the Youngstown Safety Limit Stop and its many advantages.

THE ELECTRIC CONTROLLER & MFG. CO.
2698 EAST 79TH STREET • CLEVELAND 4, OHIO



CLEVELAND CRANES

MODERN ALL-WELDED STEEL MILL CRANES

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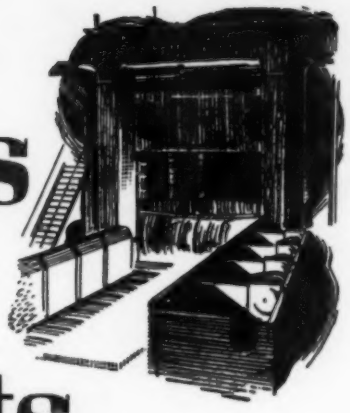
Crops *and* Shorts



DESPITE the well-publicized tightness of the long-term money market, private financing of companies in the steel field amounted to $464,995,000 in 1952. Largest loan was Reserve Mining Co.'s $148,000,000, 4.25 per cent 1980 first mortgage bonds. Youngstown Sheet and Tube Co., Kaiser Steel Corp. and Armco Steel Corp., issued bonds totaling $102,500,000 at interest rates of 3.0-4.75 per cent. Allegheny Ludlum Steel Corp., Continental Steel Corp., Copperweld Steel Co. and Lukens Steel Co. issued notes totaling $27,000,000 at rates of 3.75-4.50 per cent, and Granite City Steel Co. sold $3,300,000 of 5.50 per cent preferred stock.

▲

FINANCIAL reports from steel producers for the first half of 1953 look good, showing net incomes running 75 per cent or more higher than the first half of 1952, which was affected by the steel strike.

▲

TAKE-HOME pay probably got its name because there's no other place you can afford to go with it.

▲

STATISTICS from the American Iron and Steel Institute show that in 1952 the industry consumed 112,468,109 net tons of iron ore, 87,270,977 net tons of coal, 59,209,859 net tons of coke, 53,189,-111 net tons of scrap, 33,234,687 tons of fluxes, 208,989,000,000 cu ft of natural gas, 2,240,125,049 gallons of fuel oil, 262,807,992 gallons of tar and pitch, and 25,945,000,000 kwhr of electric power.

▲

TOTAL exports of steel products from the United States in 1952 were 4,160,000 net tons, 27 per cent over the previous year.

▲

ANNOUNCEMENTS from the Atomic Energy Commission indicate remaining obstacles to civilian use of nuclear power are chiefly economic and political: To produce atomic power competitive with that from conventional fuels, and with opportunity for free enterprise without danger to national security. Plans involve the use of conventional steam turbines, using steam generated by heat withdrawn from a reactor through a heat exchanger. It is estimated that a 200,000 kw plant would cost about $50,000,000.

▲

INDUSTRIAL furnace business for the first half of 1953 amounted to 93 per cent of the first half of 1952, according to the Industrial Furnace Manufacturers Association. Export business accounted for about four per cent of the total.

▲

A correspondent tells us that women's slacks don't come in odd sizes, but just get that way from wear. We've always heard that women who are well-reared shouldn't wear slacks.

▲

B. F. FAIRLESS, chairman, United States Steel Corp., looks for third quarter operations at or near capacity, with the fourth quarter somewhat lower. He said the drop-off will occur on a product by product basis and will fluctuate in different areas of the country.

▲

DURING 1952 the United States exported approximately $3,000,000,000 worth of machinery and equipment, accounting for 20 per cent of total U. S. exports. During the past few years, 11 or 12 per cent of total machinery and equipment sales was exported, ranging about 5 per cent for electrical machinery and equipment and 19 per cent for metalworking machinery.

▲

REMEMBER the good old days when you got the landlord to fix anything by just threatening to move?

▲

ARTHUR D. Little, Inc., recently came under an unusual form of ownership when its employee-retirement trust purchased the common stock shares of individual holders. No change in the company's management or methods of operation are expected — but we can't help but wonder how labor negotiations would be carried on under such a set-up.

▲

THIS year brings important milestones to a number of important industrial concerns: Ford Motor Co., founded 50 years ago; General Electric Co., 75 years; Wm. B. Pollock Co., 90 years; Jones & Laughlin Steel Corp., 100 years; and Mackintosh-Hemphill Co., 150 years.

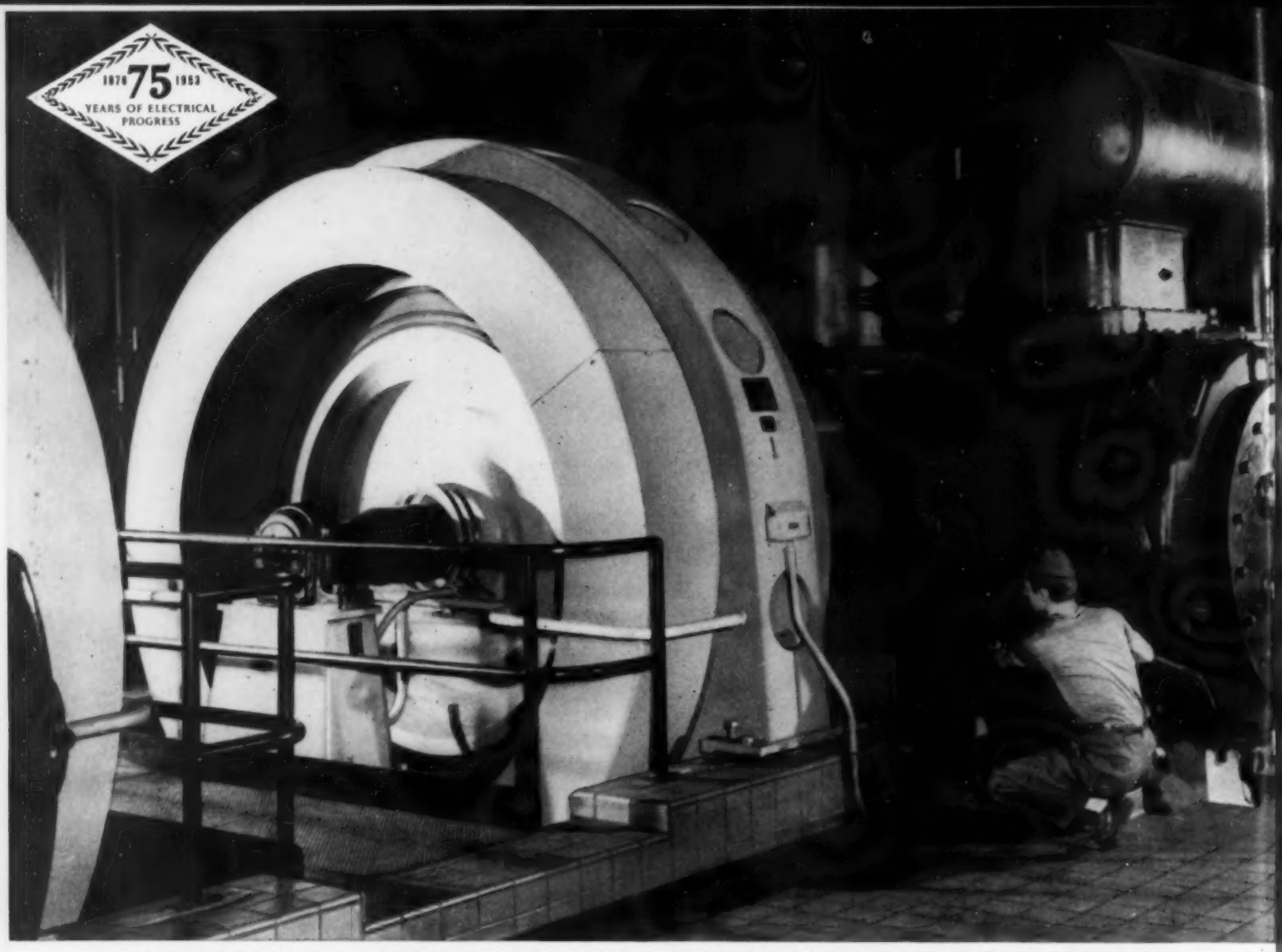
▲

THEY say a man who gives in when he's wrong is wise. If he gives in when he's right, he's warned.

▲

THE Democrats have a gag about a new dance which they call the "Republican Glide." It's one step forward, two steps back, hesitate and side step.

1876 75 1951
YEARS OF ELECTRICAL PROGRESS



ONE OF FIVE 2000-HP G-E SYNCHRONOUS MOTORS USED FOR AIR-COMPRESSOR DRIVES AT FORD MOTOR CO., ROUGE PLANT.

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Dependable G-E Synchronous Motors on 24-Hour Assembly-line Service

Ford Motor Company uses G-E synchronous motors for air-compressor drives

Compressor-motor dependability is really put to test on 'round-the-clock service at Ford Motor Company's Rouge plant. Compressed air is used 24 hours a day on many assembly operations, and a dependable supply is vital to keep production lines moving.

To furnish this all-important air, five 2000-hp G-E synchronous motors drive reciprocating compressors continuously—with only slight reductions in demand on certain shifts.

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The next time you consider a drive for heavy, continuous-service equipment be sure to call in your G-E representative to discuss any special application problem you may have. Have him explain the many money-saving uses for G-E synchronous motors and point out their operating economies.

In the meantime, you can obtain more information on G-E synchronous motors by writing for these publications: GEA-5332, "Low-speed Synchronous Motors," or GEA-5426, "High-speed Synchronous Motors." Write to Section 770-29, General Electric Co., Schenectady 5, N. Y.

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GIVE LONG, DEPENDABLE SERVICE . . .

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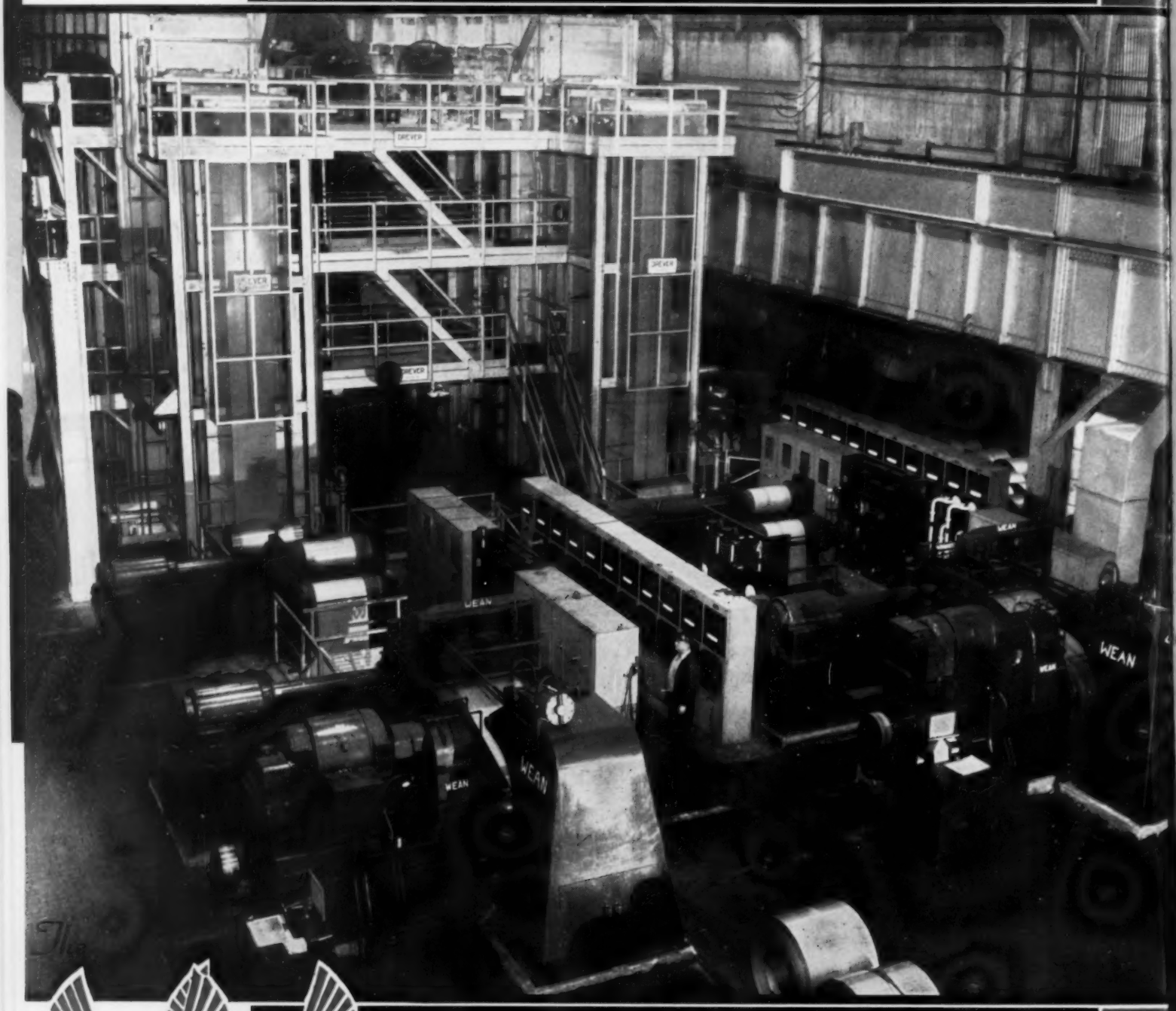
Insulating materials, manufactured in our own factories by the most modern methods, conform to rigid G-E specifications and are applied by experienced operators, above. Thus coils are uniform, interchangeable, mechanically rugged, and moisture resisting.

4. LOW-RESISTANCE CONNECTIONS . . .

For dependable operation, stator windings are silver brazed, as shown above. Joints of this type have low electrical resistance, exceptional thermal and mechanical strength. These important properties are difficult to obtain by other methods.

tower type annealing



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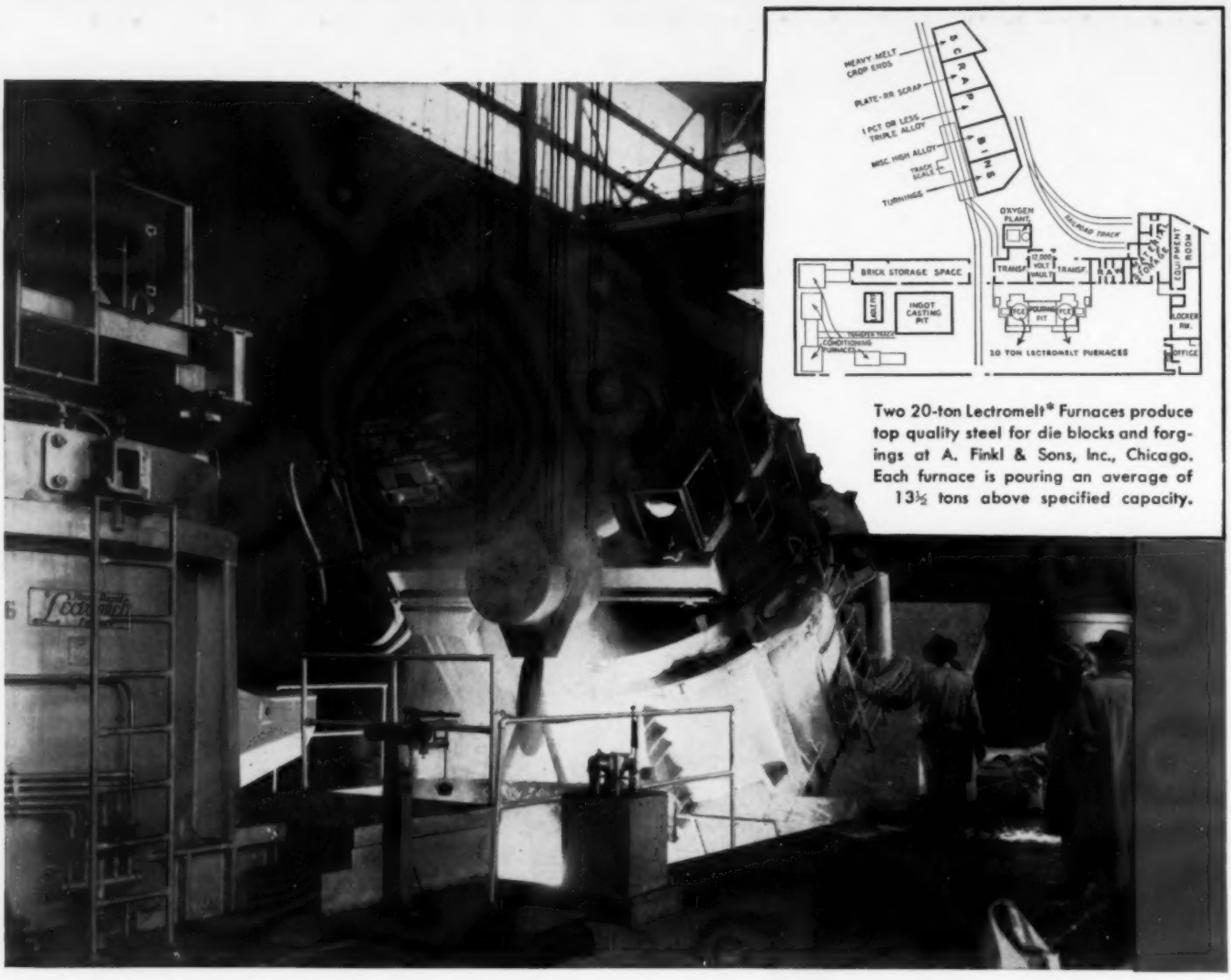
PLASTIC BINDING U. S. PATENT NO. 1970285 LICENCE NO. 120



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WHEN YOU MELT... MOORE RAPID *Lectromelt*

EXPERIENCES WITH OXYGEN CONTROL IN OPEN HEARTH FLUE GASES

By F. P. HUBBELL
Superintendent Fuel Dept.
Homestead Works
United States Steel Corp.
Munhall, Pa.

. . . . initial experiences with the 0_2 control system described have been accompanied with some trouble . . . .

▲ THE control of excess air in open hearth flue gases has long been recognized as desirable for good furnace operation. The chemical analysis of the flue gas leaving an open hearth furnace is a direct measure of the combustion efficiency of the furnace. It materially affects fuel economy, furnace maintenance requirements, and can noticeably affect production rates and quality. The deficiency or excess air in the flue gases will vary somewhat with furnace construction, types of fuel used, and firing practices. There is however, an optimum excess air which will give maximum overall operating efficiency. Usually this optimum excess air will be the minimum at which the furnace can be operated while maintaining complete combustion in the laboratory of the furnace. Operating a furnace at a deficiency of air results in unburned fuel loss, decreased refractory life, and carry-over of fuel into the checkers. This carry-over accelerates furnace slowdown as the furnace campaign progresses. Operating a furnace with too high excess air increases heat loss to the stack, decreases regenerated air temperature with resulting lower flame temperature and results in increased fuel costs. Each ten per cent increase in excess air decreases the flame temperature approximately 200 degrees. Since heat transfer in open hearth furnaces is almost entirely by radiation, any lowering of maximum obtainable flame temperature directly affects furnace production rates.

In order to obtain representative flue gas samples for combustion purposes, the selection of the sampling point is of utmost importance. The sample should be taken at a point where combustion is complete, but ahead of any appreciable air infiltration. Our experience indicated samples should be taken in the furnace downtakes at least one foot below the top of the air wall and toward the tapping side of the furnace. In order to find the best sampling point for duplication of results, explorations should be made across the transverse of the uptake.

Probably the oldest and best known method of determining excess air is by quantitative analysis of the flue gas. In combustion analysis, determination of CO_2 has sometimes been used as a measure of excess air since there is a definite relationship between CO_2 and excess air when a single fuel of uniform composition is burned under controlled conditions. The excess air for different fuels varies tremendously with the CO_2 content. If excess air measurements are to be made continuously from charge to tap on an open hearth heat, the CO_2-excess air relationship will be distorted beyond workable limits by the metallurgical reactions from the bath.

Since there is substantially a constant relationship

between the oxygen content and excess air in open hearth flue gases, regardless of the type of fuel or the stage of the heat, oxygen content of flue gases serves as a stable guide in determining excess air. It is possible during an open hearth heat to have both oxygen and combustibles simultaneously present in the flue gases being analyzed, and therefore it is always advisable to check for combustibles in determining the optimum excess air.

The standard orsat has long been used to analyze flue gases for CO_2, O_2, and CO. It offers flexibility in use and has been of great value in determination and correction of firing practices. However, such analyses provide only momentary or spot glimpses of combustion practices and do not meet the full requirements of satisfactory operating guides. In recent years considerable work has been done to develop a suitable continuous sampling system which will make possible a better correlation and use of flue gas analyses. Due to the constant relationship between oxygen and excess air content of the flue gases, regardless of the type of fuel or gas generated by the metallurgical reactions of the bath, a continuous

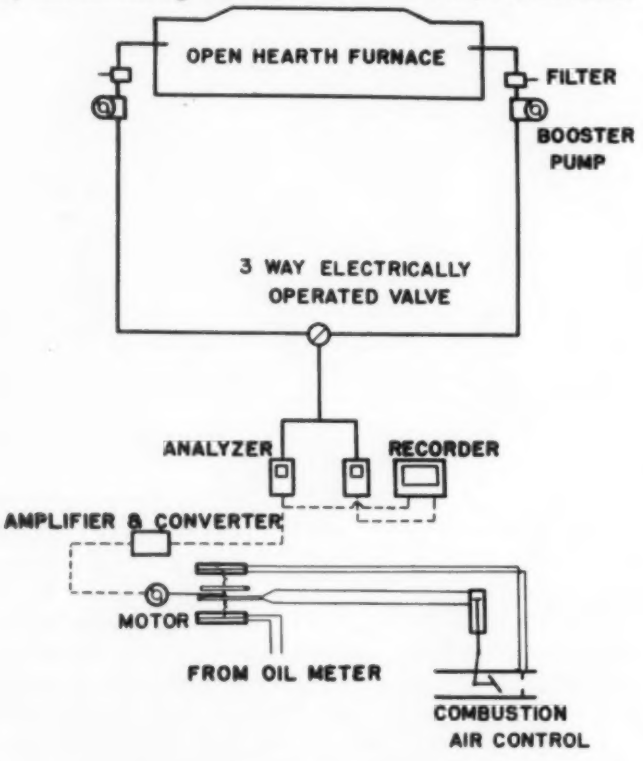

Figure 1 — Schematic layout of continuous sampling and control system.

record of oxygen content in the flue gases serves as an excellent guide for combustion practices. There are several types of continuous oxygen analyzing and recording instruments now available, any of which will give satisfactory results in analyzing the sample. However, major difficulties are encountered in supplying the analyzer with a clean moisture-free sample which is representative of the open hearth furnace combustion practice.

During the processing of a heat of steel, practically all of the dust and fume emitted from the open hearth furnace originates from the chemical reactions of the bath, the physical action of the flame on the charged material, the agitation of the bath, and the combustion of the fuel. There may be other minor sources such as the erosive action of the gas stream on the refractory lining.

Extensive flue gas sampling has indicated that the waste gases leaving the furnace contain solid particles having a total weight of approximately 3000 pounds for a normal medium carbon structural grade heat when using tar as a fuel. These particles are either spherical or hexagonal in form with seventy-five per cent of the loading by weight being less than five microns in size. The gases also contain a moisture content of twelve to twenty-five grains per cubic foot of standard gas. This moisture causes the dust particles to coagulate, forming larger particles which have a tendency to clog the sampling system.

In October 1951, an installation for continuous sampling and control of oxygen content of furnace flue gases was made on a 225-ton basic open hearth furnace. A schematic layout of the installation is shown on Figure 1. This equipment is designed to maintain a predetermined oxygen content in the flue gases by variation of combustion air to the furnace. The sampling, analyzing, and control system consists of the following items:

1. Water cooled sampling tube filter, and booster pump located at end of the furnace.
2. Approximately 150 feet of standard ⅜-in. pipe from each booster pump to the analyzing instrument.
3. A three-way solenoid valve, located adjacent to the analyzing instrument, for selection of the proper sample line from booster pumps.
4. A continuous analyzing instrument for oxygen and combustibles determination.
5. A converter with a control dial calibrated in percent oxygen, duplicating the calibration of the oxygen meter in the analyzer.
6. A amplifier for any unbalanced emf resulting from variations of oxygen content above or below the desired setting on the converter control dial.
7. A drive motor, connected to the fuel/air ratio control, which receives any unbalanced signal from the amplifier and makes the necessary corrections to the combustion air supply of the furnace.
8. A timer to adjust the rate of correction by the drive motor on the fuel/air ratio control.
9. A timer operated in conjunction with the furnace reversal system which disengages the combustion air correction motor for a predetermined interval following each furnace reversal.
10. A two-point curve-drawing electronic strip chart recorder for recording the percentages of oxygen and combustibles as determined by the analyzer.

The water-cooled sampling tube shown in Figure 2 is simple in construction and relatively inexpensive to make. The water jacket and supply pipe are made from 2-in. and 1-in. standard pipe. The inner sampling tube is a 1-in. stainless pipe which contains a flat stainless strip twisted to form a corebuster. This corebuster improves removal of condensate in the sampling tube. The four-way tee provides a removable plug for cleaning and a drain leg connection. Normal maintenance on this unit requires cleaning out the sampling tube and draining the condensate drain leg once every forty-eight hours. This sampling tube will operate continuously on relatively dirty plant water at an inlet pressure of ten to

fifteen psi while discharging against a twelve foot head into an overhead furnace bosh. While trouble had been anticipated in keeping the sampling tube open, fortunately no trouble developed.

The filters for cleaning the sample before the booster pumps are very important factors in the success of this installation. Initially, a tank-type separator was installed before the filter. It was thought that the larger dirt particles and some of the condensate would be dropped from the sampling stream in this baffled low-velocity container. However, no appreciable benefits pressure from these pumps. Under these conditions approximately 500 cubic inches per minute of sample will be pumped to the analyzer.

The continuous analyzing instrument, converter, amplifier, three-way solenoid, and timers are located in a cabinet adjacent to the furnace control board. The electronic strip chart recorder is mounted on the furnace control board. The flue gas sample from the booster pumps is directed to the analyzing instrument by the three-way solenoid valve which is sequenced with furnace reversals.

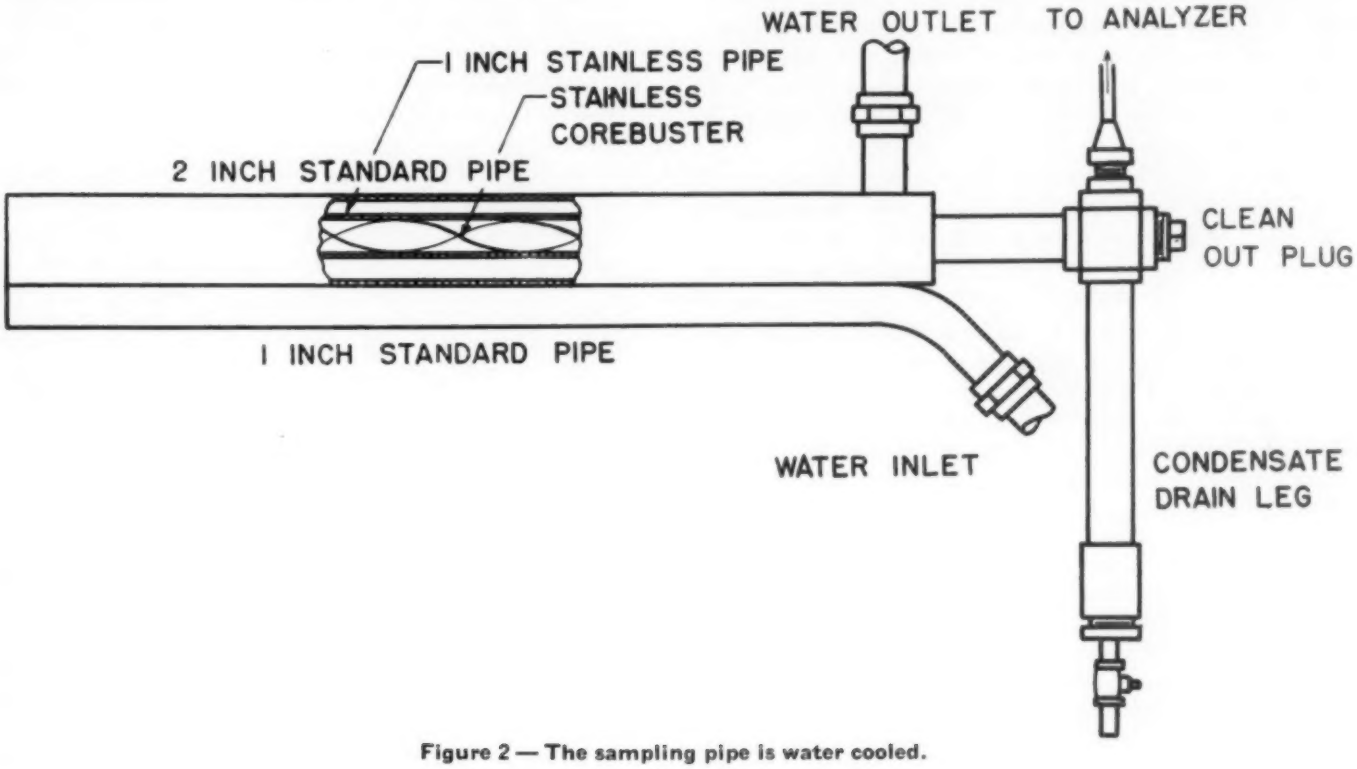

Figure 2 — The sampling pipe is water cooled.

were derived from this unit and it was discarded. The first type of filter used consisted of a lucite tube packed with cotton. The degree of packing was very critical. Packing the cotton too tightly resulted in plugging of the filter and caused failure of the booster pumps. If the cotton was packed lightly, the sample route through the filter would follow the path of least resistance and result in channeling. This gave very little filtering action and resulted in excessive dirt being carried into the booster pumps. Best filtering results on this installation were obtained with a commercial type filter of yarn and wire mesh. This filter baffles the sample stream to the bottom of the filter container where trapped moisture and dirt can be removed through a drain valve. This filter has sufficient capacity so that the velocity of the gas through the filtering element is at a minimum, but does not create a detrimental time lag in withdrawing the sample.

The booster pumps for withdrawing the sample and pumping it to the analyzer are sequenced to start and stop automatically with furnace reversals. A pump is located at each end of the furnace on platforms just below charging floor level. These pumps are equipped with a vacuum switch to prevent overloading caused by a plugged sampling tube or filter. Normal operating requires a 12-in. Hg vacuum and a 4-in. Hg discharge

The analyzing instrument which includes a suction pump and motor, requires 100 cubic inches per minute of sample with the balance of the 500 cubic inches per minute from the booster pumps being bled off to the atmosphere. This 500 cubic inches per minute delivery gives approximately a sixty-five second delay in transferring the sample from the furnace to the analyzer. If this pumping rate is increased, the delay time will be reduced but the greater volume of sample being handled will accelerate plugging of the sampling tubes and filters.

The continuous analyzing instrument operates on a catalytic combustion principle for the determination of oxygen and combustibles in the flue gas sample. This instrument sends out emf loads proportional to the percentages of oxygen and combustibles in the sample. The emf output from the oxygen analyzing meter is transmitted to the converter which has a control dial calibrated in percent oxygen which can be set for desired oxygen values ranging from zero to twenty per cent. When the oxygen content of the flue gas sample does not correspond to the desired value set on the converter control dial, a condition of electrical unbalance exists. This electrical unbalance is received by the amplifier which energizes the fuel/air ratio drive motor for proper correction of combustion air supply to the furnace. As

soon as the oxygen content of the sample has returned to the desired value, the electrical unbalance is reduced to zero and the fuel/air ratio drive motor comes to rest. There is a selector switch on the amplifier unit for manual operation of the fuel/air ratio drive motor.

In attempting to control something as large as an open hearth furnace and with the sixty-five second sample transfer lag, the corrective action of the fuel/air ratio drive motor must be in very small increments as related to time. In order to adjust the rate of correction to the right value, a timer is interposed between the amplifier and the motor. This timer contains a motor-driven cam which closes a contact for a certain portion of cycle time. The cycle time of the timer is variable and can be selected by a combination of gears. Best results on this installation were obtained with timer contact closure of two seconds every sixty seconds.

Due to wide fluctuations in oxygen content of the sample during furnace reversals, an additional timer is required. This timer stops any corrective action of the fuel/air ratio drive motor for a period of two minutes from the start of each furnace reversal.

To record the results of this oxygen control system, a two point curve-drawing electronic strip chart recorder is used. The recorder is a stand and 0 to 2000 F instrument. By variations to the cold junction compensator, a center zero is obtained on the instrument. The two emf output circuits from the analyzing instrument, representing percentages of oxygen and combustibles, are connected to the recorder. A standard temperature chart is used with an indicating scale, calibrated for oxygen and combustibles located above the chart. An electrical disturbance introduced by the recorder changing from oxygen record to combustibles record causes a shift in oxygen control point. This makes satisfactory control impossible if both oxygen and combustibles are recorded. However, by recording only oxygen, a satisfactory control point can be maintained. It is hoped that this dual recording difficulty can be eliminated.

As with other continuous sampling systems, considerable difficulty has been experienced in maintaining satisfactory operation. The weakest points in this system are the booster pumps and the long pumping lines to the analyzing instrument.

Although the sampling tubes normally remove all the condensate, additional condensate was formed between the sampling tubes and the booster pumps during cold weather. This caused considerable difficulty with the filters and booster pumps. This condensate, formed after the sampling tubes, increased the rate of filter replacement to twice the normal requirements. It caused serious plugging of inlet pump lines, and resulted in excessive pump maintenance. Any condensate which entered the pumps entered the ⅜-in. sample lines to the analyzing instrument. This resulted in some plugging in these lines and caused additional maintanence to the analyzing instrument. The analyzing instrument used is not rugged enough to operate in temperatures below freezing. The suction pump in the instrument would bind and overload the motor. Heater units were applied with partial success. In general, excluding severe cold weather, the sampling tubes will remove sufficient condensate to prevent serious difficulties in the sampling system. The yarn wire-mesh filters now used have proved superior to the original cotton filters and it is believed they will give more satisfactory results during cold weather.

This installation requires many and varied manhours of maintenance for continuous operation of the control system and is serviced by fuel engineers and instrument repairmen. Many times these men were not available for required service and the control system would be inoperative for several days. No accurate records of maintenance manhours were kept but rough estimates indicate twelve hours per week.

Due to the difficulties encountered with this control system and the varied production requirements of the furnace, no definite conclusions covering furnace performance while on control have been reached. However, it is believed that a combustion control of this type has definite possibilities and will serve in the future to improve open hearth combustion practices.

Design changes to this oxygen control system are being developed to eliminate difficulties experienced with the booster pumps and the sample transfer lag. In the near future, two analyzers, one at each end of the furnace, will be installed at cellar level. The present booster pumps will be removed from service. The sample will be withdrawn from the furnace by a small suction pump, located inside the analyzing instrument case. Each instrument will be equipped with indicating meters showing the percentages of oxygen and combustibles in the sample. All controls and adjustments for the analyzing instrument will be internally mounted so that calibration adjustments can be made at their location. Each instrument will be connected by an eleven-wire cable to a control rack located adjacent to the furnace control panel. This rack will contain two panels with boxes behind them containing the necessary parts and wiring. In normal operation all that will be visible will be four illuminated meters and a series of pilot lights. There will be a combustible and oxygen meter for each analyzing instrument. There will be an indicating light showing when the furnace is on automatic oxygen control. The analyzing instrument will be provided with automatic zero correction which will occur during the first fifteen to thirty seconds of each furnace reversal. Indicating lights on the panel will tell when this action is taking place. Additional lights will be installed to show plugged sampling lines and to indicate when the automatic zero adjusters have reached the end of their travel and manual adjustments must be made.

At the start of each furnace reversal the appropriate analyzing instrument will be switched into service. At the same time a timer will be put into operation for fifteen to thirty seconds to operate solenoid valves for automatic zero correction in the analyzing instrument. After this fifteen to thirty second interval, the timer will actuate the valves so sampling begins. As with the present installation, emf from the analyzing instrument will be transmitted to the converter and any electrical unbalance will be amplified to operate the fuel/air ratio drive motor. It is hoped that this system will permit dual recording of oxygen and combustibles percentage on the strip chart recorder.

This installation should require considerably less maintenance and reduce the sample transfer lag from sixty-five seconds to approximately fifteen seconds. The proposed installation will be given close attention and it is hoped that satisfactory continuous control may be accomplished.

DISCUSSION

PRESENTED BY

J. G. SPARKS, Industrial Marketing, Cities Service Oil Co., Chicago, Ill.

JOHN R. GREEN, Metal Producing and Ceramic Industrial Sales Manager, Minneapolis-Honeywell Regulator Co., Philadelphia, Pa.

F. P. HUBBELL, Superintendent Fuel Dept., Homestead Works, United States Steel Corp., Munhall, Pa.

R. A. LAMBERT, Superintendent, Steam and Combustion, Jones & Laughlin Steel Corp., Pittsburgh, Pa.

J. G. Sparks: I wish to thank Mr. Hubbell for a very clear, concise report of facts involved in the experimental development of an open hearth fuel air ratio control, one which, as we all know, has received wide acceptance throughout the steel industry.

I would like to point out that our equipment used in this experimentation is one of the early models made in 1940, and it was not designed for this type application. However, we are of the opinion that facts had to be established, such as Mr. Hubbell has afforded in this paper before the necessary improvements could be made to achieve a more satisfactory apparatus. I believe we are all aware of the fact that if this apparatus will control an open hearth furnace, it will be applicable to all types of metallurgical furnaces, because, as we know, the open hearth is definitely the acid test.

John R. Green: Mr. Hubbell has given valuable information on a subject which is certainly dear to the heart of many fuel engineers, but a headache to the maintenance men. As has been stated, the sampling and the cleaning problems are the greatest obstacles to the extended use of any of this form of equipment. A number of analyzing units are available, which are fast enough and ruggedly designed to handle reasonably clean gas samples. The diameters of the sampling pipes, and the lengths of the connecting tubing or filter capacities require a happy balance to secure a minimum of solid removal, with sufficient speed of response.

The steps proposed for future installations all seem to be in the right direction, but may very well call for a different sampling tube size or suction rate for the maximum results in the over-all system. A question might be posed here concerning the location which has been found most practical in this particular furnace design, as far as the insertion of the sampling tube beyond the inner wall face of the furnace wall.

The principles of having oxygen analysis trim a fuel-air ratio for airflow control systems of any design seems to be the only sensible approach at the present stage of the art of gas analysis, the easier this trimming can be accomplished, the better the results.

Now, as an instrument control engineer, a few additional suggestions could be made. First, the use of a proportional and reset action either by pneumatic or electrical means should give greater stability to the control system than the floating operation which has been described. With its shorter operating periods, as shown on this floating type of system, a total time period of only 16 seconds out of a 10-minute reversal cycle, could be increased practically 30-fold by a proportional method of control.

Feed-back, which was mentioned between instrument control circuits, can certainly be eliminated or entirely removed as a possibility by performing the control function from the recording instrument.

There is one further question which might be of value to prospective users of this type of equipment. Since control is being performed from the oxygen measurement, do you consider that more than an occasional manual checking of the per cent of combustibles is an essential to a properly operated oxygen control system?

F. P. Hubbell: To answer Mr. Green's question about the location of sampling tubes, we locate the sampling tip approximately halfway across the uptake, which in this case is about three feet in from the inner face of the furnace end wall. We have taken samples transversely across the uptakes and found very little variation between locations in the uptake.

As far as the proportional and reset operation of the correction motor, I do not doubt we could probably improve the method of correction as Mr. Green pointed out. It can undoubtedly be done. Until this time it has not been given much thought.

With reference to manually checking percent of combustible, we feel it is most desirable and should be recorded continuously along with oxygen analysis.

R. A. Lambert: Oxygen control of open hearth flue gases by controlling input air has been discussed for a good many years, but this is the first time that I know of that recorded oxygen has been used to directly control the combustion air from the open hearth forced draft fan.

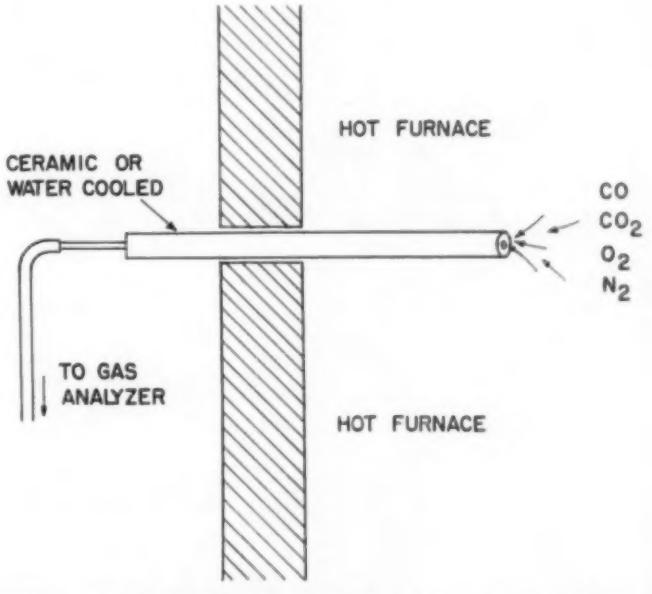

Figure 3 — Gas reactions may take place at the input end of the sampling tube.

I would like to bring out one thought that some of us may neglect to consider. With any sampling system in any furnace atmosphere which is near the low excess air content, the gas analysis as indicated by either an orsat

machine or heat prover can be deceptive. Figure 3 illustrates this point. You will note that as we draw the molecules of gases, CO_2, N_2 O_2 and CO, (if there be any) toward the suction hole of the sampling tube, the CO comes in close proximity to the O_2 present and a so-called secondary combustion can occur which will burn any CO present into CO_2. Therefore, the gas analyzer may indicate no presence of CO in the furnace atmosphere which can, in small quantities, actually exist.

If we are at 10 per cent or less of indicated excess air, there is likelihood that we may have combustibles present (hydrocarbons or CO) in the actual atmosphere which we want to sample. Since the open hearth furnace operates with a relatively large fuel input and fairly long flame, it is my belief that such furnaces should be operated with not less than 15 per cent excess air as would be indicated on a sampling apparatus.

Member: I would like to know what percentage of availability the author has with this control?

F. P. Hubbell: Availability has not been very good. I will not say it is the fault of the system. In a lot of cases it was because we were not able to devote sufficient time to the installation. We started this unit without trying to do any recording, and after it was put in operation we decided to record and had quite a difficult problem in trying to have a recorder tied across the circuits, due to the way our circuits were wired up. If the instrument closed two circuits simultaneously, we would burn out part of the measuring circuit in the heat prover. There was considerable time spent in correcting this condition.

I cannot give you any exact figures on availability, only to say that it has not been in service as much as it could have been with a little more attention on our part. I indicated around 12 hours per week as normal maintenance requirements. That varies somewhat with the type of ore we had in the particular furnace we were using. The open hearth shop we were applying this unit on has rather wide fluctuations in charge and feed ores, which resulted in periods of excessive plugging in the filters and some trouble with the pumps.

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FLASH WELDING AND HIGH SPEED COLD REDUCTION OF STRIP STEEL FOR TIN PLATE

By JOHN WARGO

Tin Plate Metallurgist and Chief Inspector

and

RAY C. BRUNNER

Development Engineer

Jones and Laughlin Steel Corp.

Aliquippa, Pa.

. . . . successful and economical operations of high speed tinplate mills is dependent on a good welding procedure . . . .

▲ DURING the past decade that phase of tin plate production related to cold rolling has undergone a striking development which is perhaps without parallel in industry. Stimulated by the tremendous and growing demand for this type of flat rolled product, recent cold mill installations with delivery speeds in excess of 4000 fpm represent a production expansion far beyond that experienced or anticipated ten years ago.

The successful operation of the present high speed mills has resolved to a large extent the early speculation as to the ultimate speed in cold mill rolling. However, improvement of steelmaking and processing prior to cold reduction to meet the special and more stringent requirements for satisfactory high speed rolling is also necessary to realize maximum benefits from such mills.

Obviously for successful operation, a high speed mill must roll a commerical product at or near the rated capacity. Excessive delay time or frequent rolling below normal speeds rapidly lowers the production to a level comparable to slower mills. With these objectives, of reducing delay time, and operating at the highest possible speed to attain the production capacity intended by the mechanical and electrical design, an extensive and continuing program of study has been under way since the high speed five-stand tandem mill began operation at the Aliquippa Works. This program has involved electrical, mechanical, and metallurgical problems, and their successful solution has helped in the development of improved practices which have benefited over-all mill production and quality.

An important and ever present problem on the Aliquippa mill, and one frequently mentioned as a major deterrent to high speed mill operation, has been the ability to roll welded coils at speed.

Due to limitations imposed by ingot practice and hot strip rolling, the average hot band received at the Aliquippa Works for further processing is approximately 6000 to 8000 pounds in weight. For continuous operations through the pickler, and to build up the large multiple coils for tandem mill cold rolling, the welding of hot bands is necessary.

If the quality of the welds does not warrant rolling at speed, the frequent slowdowns substantially reduce production. Also, on slowdowns, the rapid changes in speed to decelerate and accelerate when the weld is passed through the mill, demand the utmost in mill equipment and operator skill to control the many variables involved in rolling the welded section and keep off-gage to a minimum. At the worst, a weld break can cause the loss of one or more mills, and considerable time delay to change damaged mill rolls.

Flash butt welding of the hot bands by the electrical resistance method is performed by a hydraulic type machine, rated at 1400 kva, which is an integral part of the pickler. This machine was especially designed for welding hot bands in the steel grades, widths, and gages applied to tin plate production. To make the welding operation as simple as possible, the latter phases of the welding cycle, which include clamping, feed, and upset, are automatic and air hydraulically controlled.

Before discussing the welding procedure the preparation of the coil ends for welding should be reviewed, because the proper conditioning of the coil ends is necessary for a satisfactory weld. Correct positioning of the strip with side guides for a square or bias cut at the up-cut shear is important. The cut should be clean, with no burr or crimp along the sheared edge. Coil ends which are badly waved or damaged at the edges must have an additional crop to remove these defects, as they may cause an overlap of the butted edges during feeding, and produce a poor weld. The practice at the up-cut shear determines to a large extent the rapidity and accuracy with which the strip ends are aligned vertically and horizontally in the welding machine before the strip is clamped and welded.

At the up-cut shear the coil ends are inspected for piped steel. The operator at this point can also detect piped steel by the wrinkled pattern on the face of the strip as it runs out of the processor.

Perhaps in the near future a rapid and efficient method for determining the soundness of the steel at the coil ends will be perfected. Such a device would be an important and necessary step in achieving a perfect weld for cold reduction.

The procedure through a normal welding cycle begins with the tail end of the coil as it comes out of the processor. This end is sheared off at the up-cut shear with the precautions mentioned previously, then advanced and stopped beyond the welder dies. The motor driven gage head which is V shaped and slightly tapered to provide a gap between the adjacent coil ends, is lowered at constant speed from the up position, and as it travels downward between the vertical faces of the dies scrapes off any adhering scale or flash particles. From the lowest position in the crank cycle, the gage head continues to raise to a predetermined setting. The approach to this stop is manually controlled at inching speed. With the gage head in position, the tail end of the leading coil, which had been run beyond the dies, is brought back to the delivery side of the gage head and looped; the pressure of the loop holding the coil end uniformly against the gage head. The head end of the next coil is brought forward through the processor, and after suitable cropping at the up-cut shear is advanced to the entry side of the gage head. The strip is raised from the table level by a looping roll, and the resulting loop in addition to holding the coil end properly against the head also provides excess strip to compensate for the forward movement of the die head during the feed and upset.

The coil ends when correctly aligned against the gage head provide a V-gap to make the initial point of contact for flashing. Centering of the ends, as they press on the gage head is done by air operated vertical roll side guides located in the stationary and movable die heads. The entry guide assembly can be shifted laterally by motor drive for centering the strip after the side guides are closed.

With the strip set, the upper heads are then lowered to a slight clearance of the strip. The side guides are opened, and the strip is again inspected for proper alignment. From this point, until the welded strip is unclamped and moved to the trimmer, the welding sequence as described is automatic. The strip is clamped, and the gage head is retracted to the up position; and as the movable welder head advances rapidly to close the gap between the two strip ends, the welding heat is turned on. Beginning with the first contact at one end, the flashing becomes progressively more intense as the feed rate increases to completely fuse the weld. At this point an upset pressure is applied to simulate a forging action.

The rate of feed during the gap take-up and the flashing period is controlled by a hydraulic metering valve. Through this valving mechanism, a restricted oil flow which regulates the rate of feed becomes suddenly unobstructed, resulting in a very fast upset. Current cut-off, clamp release, raising the upper heads, and forward movement of the welded strip to the flash trimmer complete the welding cycle.

The flash trimmer, consisting of rams and cutters mounted in upper and lower housings, is of the automatic type; and, clamps the strip, trims the flash by a single stroke of the cutters across the strip, then unclamps, all in automatic sequence. The trimmer assembly can be positioned forward or backward to locate the knives accurately over the weld. Each of the housings contains a motor drive for the ram motion. Drive blocks are attached to the ram to engage with a roller type driving chain which forces the ram and cutter across the strip. The rams in the original design were supported in the housings by heavy duty roller bearing rolls. However, this method was found unsatisfactory due to the small contact area of the rollers with the movable cutting head. The wear on the cutting head was too rapid and uneven, and as a result the weld trim also became non-uniform. Hardened and ground tool steel ways designed by our people were substituted in place of the roller guides, and replaceable wear resisting metal inserts were installed on the wearing surfaces of the cutting head. These changes have been found to be very satisfactory and have improved considerably the uniformity of the weld trim.

Slippage of the clamped strip during the trimming operation is an occurrence which also contributes to poor weld trimming. To provide more adequate clamping pressure, the original spring clamping device is to be replaced by one controlled by hydraulic pressure.

Too great an emphasis cannot be placed on proper weld trim, and every effort must be made to maintain the trimming equipment in the best of condition to avoid excessive weld breakage on the cold mill.

Hot rolled bands welded at Aliquippa Works are limited to widths and gages applicable to tin plate products. To define the steel grades for reference in this paper they are broadly classified on the basis of chemistry as: (1) low carbon and low phosphorus, (2) high carbon and low phosphorus, (3) high phosphorus or rephosphorized, and (4) bessemer.

The high phosphorus grades are all mechanically capped and keyed. The remaining grades may be either rimmed or capped and keyed.

With the range in steel chemistry typical of mild steel, and the hot band cross-sectional area not being subject to any considerable fluctuation, one standard welding practice was developed, and except for slight variation of heat and flash-time is used on all material welded.

The present welding practice was first established experimentally and then evaluated on actual mill performance. Laboratory investigation and control tests

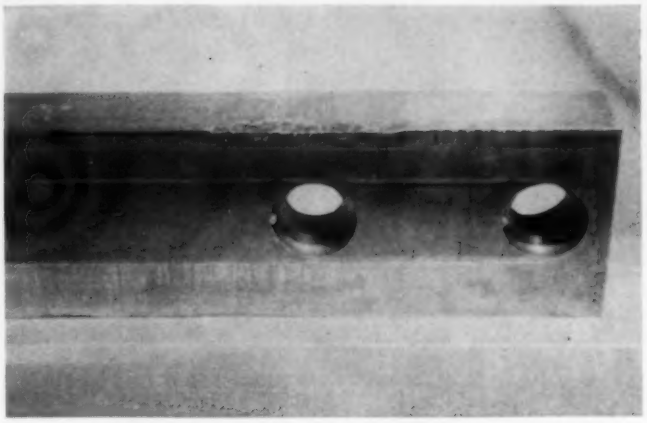


Figure 1 — Worn or chipped welding dies are detrimental to good strip welding practice. The above die is shown before reconditioning.

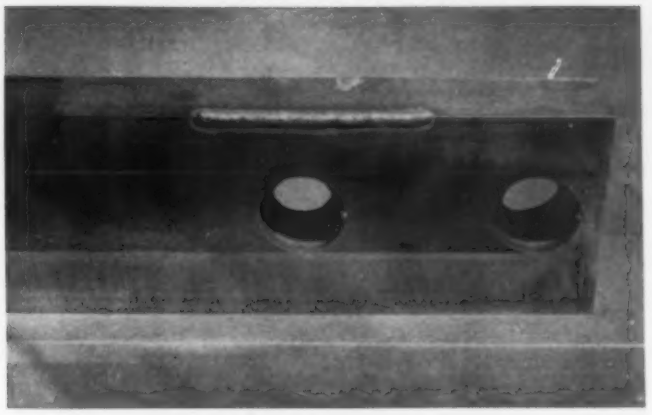


Figure 2 — In reconditioning a worn welding die, a beryllium copper bead is heli-arc welded over the chipped edge. The top face of the die is a beryllium copper insert. The bead is ground down before machining.

which are made periodically on the welds include weld hardness measurement, tensile tests, microscopic examination of weld sections, and bend tests. However, the deep etch test, where a trimmed weld section is polished and deep etched in a strong solution of muriatic acid for approximately 20 minutes, has been found to offer the best correlation as to weld quality. If after etching, the weld line is tight and non-porous, the weld is considered suitable for cold reduction.

For welding the average 0.084 and 0.090-in. hot band gages, nine to ten volts are used for nine to eleven seconds flashing periods. On the high phosphorus grades, the flash time and voltage are kept to the low side of these ranges. The upset distance and the final gap setting have been found to be very critical and each is accurately maintained at 3/16 inch for all grades and gages.

Proper maintenance of the welding machine and the weld trimmer has been a prominent factor in sustaining a high standard of weld quality. An abnormally high weld breakage on the mill often can be traced back to faulty performance of the welder or flash trimmer. From experience, certain maintenance standards were found mandatory to avoid high weld breakage.

Trimmed welds are closely inspected in respect to uniformity of weld trim and dull knives are immediately replaced. Knife clearance is another important check when uneven trim is encountered.

Periodic examination is also made of the electrical, hydraulic, and air circuits. These are checked carefully in relation to the desired mechanical operation and set-up.

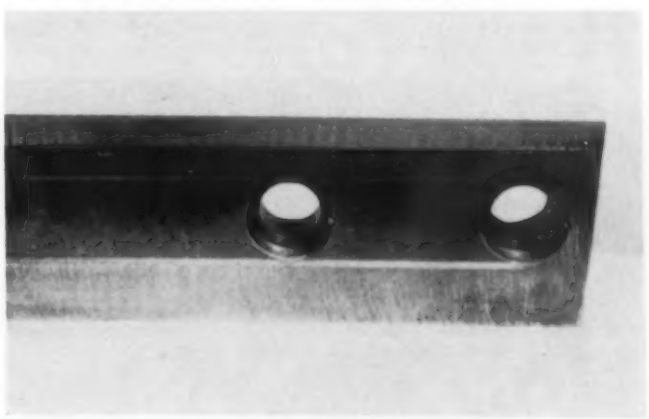
Replacement at the end of a week's operation of welder dies is undoubtedly one of the more important factors in maintaining weld quality and reducing weld breakage on the mill. The chipped and scored dies are reconditioned before further use. A description of the manner in which the dies are reconditioned would perhaps be of interest, as this method has substantially lowered the cost of die maintenance. The face of the die parallel to the strip surface is a beryllium copper insert approximately one inch in thickness when new. To the worn edge, a beryllium copper bead is heli-arc welded, and then ground. By doing this, excessive removal of the face is not necessary when grinding to square the edges. Figures 1, 2, and 3, illustrate the dies during this reconditioning process.

The fumes from this heli-arc welding operation are highly toxic and the necessary precautions must be made to protect the operator.

Weld breakage for the first half of the current year on hot bands cold reduced on the Aliquippa mill to gages ranging from 0.0077 to 0.0239-in., amounted to 2.00 per cent on approximately 36,000 welds rolled. An evaluation of the welding practice was derived from a statistical analysis of weld breaks relative to steel grade and finished gage for a three month period during which over 18,000 welds were rolled.

Generally, for the same grade a greater frequency of weld breaks can be expected on material rolled to the lighter gages. For example, the total weld breakage during the period investigated on the low carbon low phosphorus rimmed steel grades was 0.99 per cent of approximately 12,000 welds rolled to the various gages. Of the total breakage on this grade, 2.75 per cent was encountered on the lightest gages, 0.0077 and 0.0083-in. For the same grade, weld breakage on gages heavier than 0.0123-in. amounted to 0.16 per cent of almost 2000 welds rolled. These data indicate that the metallurgical quality of the welds in most instances is suitable for cold reducing. Other factors, however, apparently become more critical when rolling welds to light gages. It is believed that a good weld trim, to prevent the hard flash material from being rolled into and pinching off the soft parent metal, is an important requirement when

Figure 3 — This illustrates a completely reconditioned welding die.



rolling lighter gages. Also, the effects of the higher loads and tensions which prevail when light gages are rolled deserve study in further solving the problem of weld rollability.

The most difficult grades to weld and cold reduce in order are: (1) bessemer, capped and keyed, (2) rephosphorized, capped and keyed, (3) high carbon low phosphorus, both rimmed and capped and keyed.

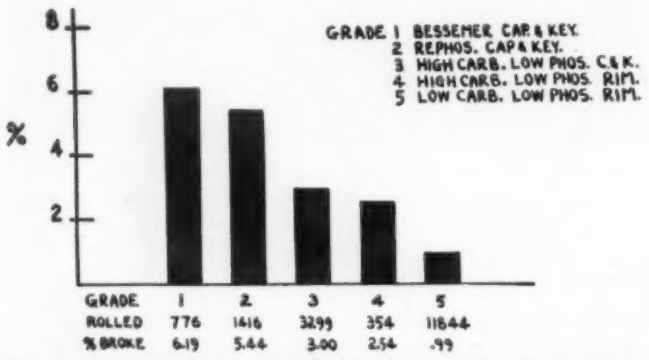

GRADE 1 BESSEMER CAP & KEY.
2 REPHOS. CAP & KEY.
3 HIGH CARB. LOW PHOS. C & K.
4 HIGH CARB. LOW PHOS. RIM.
5 LOW CARB. LOW PHOS. RIM.
%
8
6
4
2
GRADE 1 2 3 4 5
ROLLED 776 1416 3299 354 11844
% BROKE 6.19 5.44 3.00 2.54 .99

Figure 4 — Welds from grades having a high phosphorus content break most frequently when cold reduced. High carbon grades also have a high breakage frequency. Low carbon grades have the lowest weld break frequency.

Figure 4 shows graphically the weld breakage encountered on these grades in comparison with the low carbon and low phosphorus rimmed grades. Bessemer steel which is cold reduced to 0.0123-in. gage has the highest weld break frequency, 6.19 per cent. Internal steel quality, especially the prevalence of laminations, has been found to have an important bearing on the weld quality of this grade. The rephosphorized open hearth grades which are all capped and keyed have a weld break frequency of 5.44 per cent. Although showing

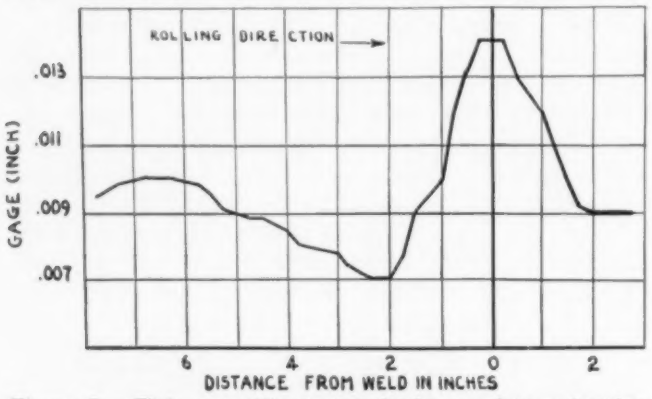


Figure 5 — This curve illustrates the incomplete reduction of the hard weld metal after cold rolling, and the effect of severe roll "bounce" immediately after the weld.

an improvement in comparison with the high phosphorus grades, the higher carbon low phosphorus grades must also be considered among the more difficult welds to make and roll; the rimmed version of this grade accounting for 2.54 per cent weld breaks as compared to 3.00 per cent breakage on the capped and keyed grade. As the ladle chemical specification is the same on the high carbon low phosphorus grades, it is interesting to note that the rimmed grade weld breakage is lower than that on the capped and keyed grade despite the fact that the rimmed steel is applied on 0.0088-in. finished

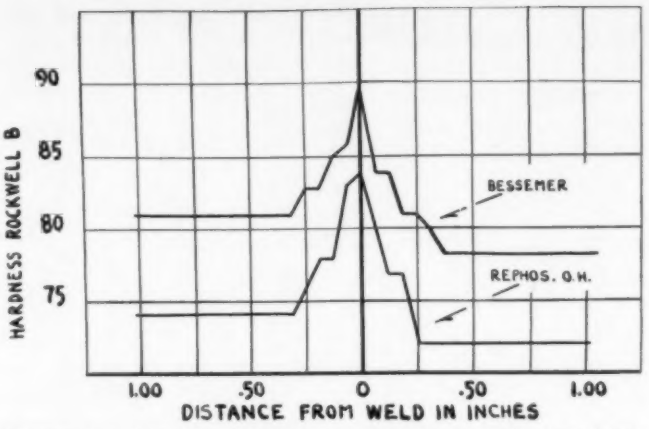


Figure 6 — High weld hardness values are typical on high phosphorus grades. Welds from these grades have the highest break frequency when cold reduced.

gage, and the capped and keyed grade on gages 0.0094-in. and heavier.

When evaluating these high weld breakage grades, it is important to know that they also represent from the standpoint of rollability the grades most difficult to

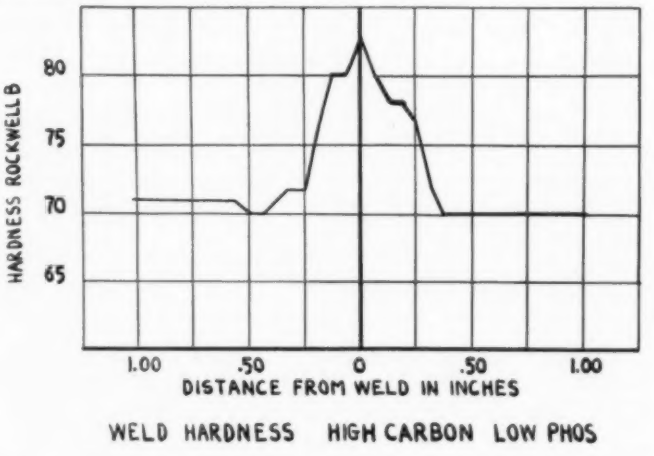
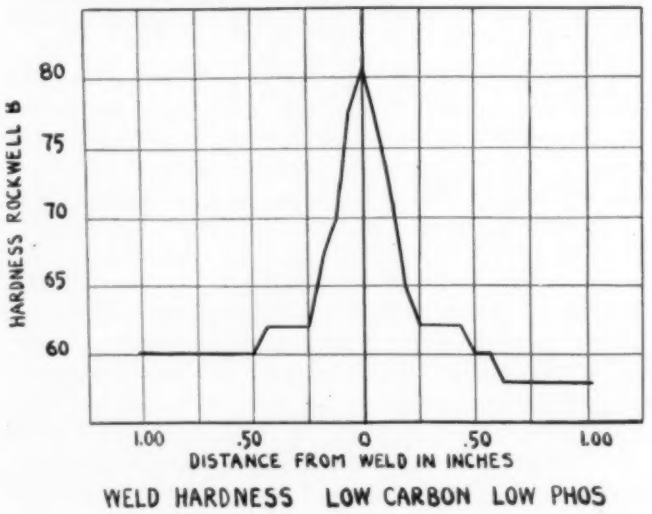


Figure 7 — Welds from this high carbon, low phosphorus grade, although not as hard as from the high phosphorus grades, have a high break frequency on the cold mill.

Figure 8 — Hardness differential between the weld and parent metal on this low carbon-low phosphorus grade is usually considerable. This grade has the lowest weld break frequency on the cold mill.



cold reduce. Because of the greater hardness, the hot bands from these grades when cold rolled require higher loads and tensions than do the softer low carbon and low phosphorus grades. The relation between rolling mill factors and weld breakage is yet to be fully determined.

Rapid changes in force and tension encountered when rolling the hard weld and the softer adjacent areas necessitate instant control and mill adjustment to avoid breakage. Incomplete reduction of the weld area (Figure 5) creates a "bounce" effect which may also result in strip breakage near the weld in some instances.

The subject of weld hardness is always included in any qualitative discussion of welds, the objective in theory being to make the welds as soft as possible to facilitate cold reduction to gage. The welds made at Aliquippa may be described as rather "hard"; the Rockwell B values as measured on the hardest zone, or the weld line, are generally 80 to 90, depending on the steel grade of the parent metal. Figures 6, 7, and 8, illustrate typical hardness traverses on welds from representative grades. To define clearly the weld line, the trimmed weld samples were polished and macro-

Figure 9 — Entry side of welder shows strip looped to hold the end tight against the gage head.

etched before Rockwell testing. Figure 6, shows the hardness traverse on welds from bessemer and rephosphorized open hearth grades. The welds from the two grades are very hard, and explain in part the high frequency of breaks encountered on these grades. Both grades are also very sensitive to cold work, and any flexing when processing through the pickler increases the weld brittleness. High carbon and low phosphorus open hearth steel welds (Figure 7) are similar in hardness to the rephosphorized grades.

Welds from low carbon rimmed open hearth grades are comparatively softer (Figure 8) with a weld line hardness of 80, Rockwell B.

In comparing the hardness profiles of the welds from the various grades, it may be noted that on the harder

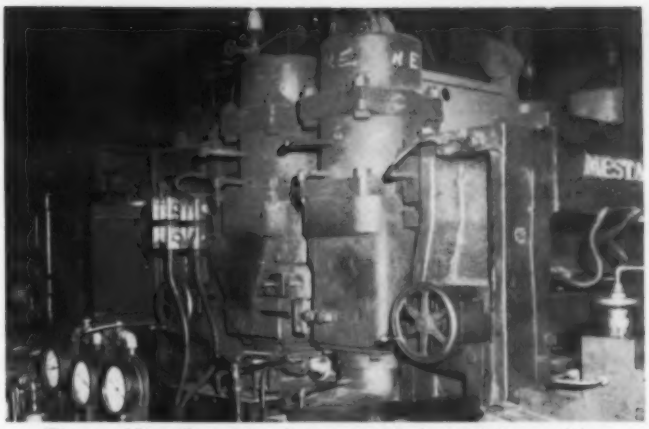


Figure 10 — Operator has a good view of the welder.

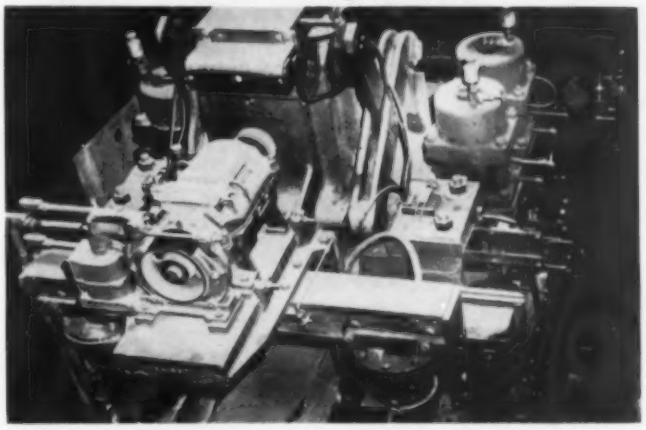


Figure 11 — Top view of welder shows motor and drive for gage head.

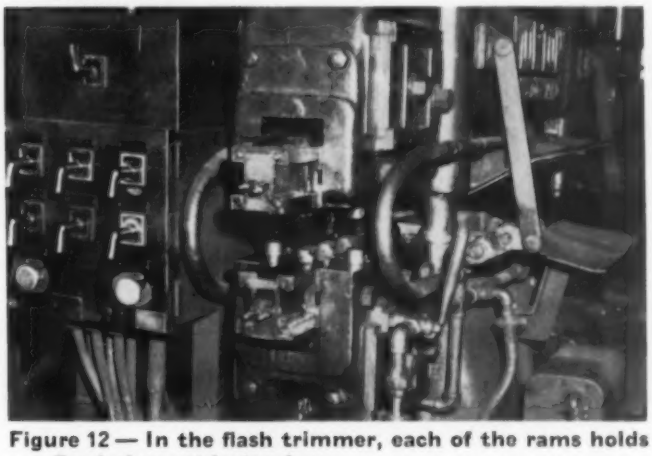
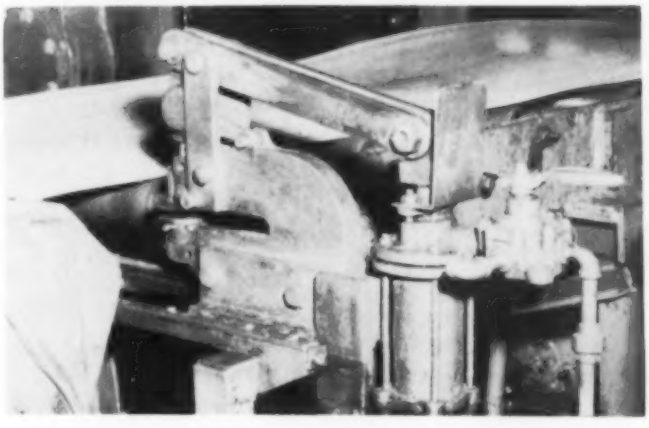


Figure 12 — In the flash trimmer, each of the rams holds five knives set in tandem.

Figure 13 — A $\frac{5}{32}$-in. hole is punched on each weld by this air actuated punch at the exit end of the pickler for identification.



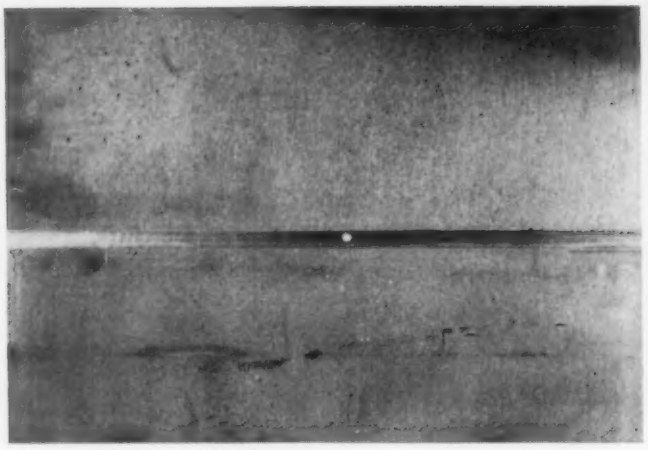


Figure 14 — Illustration shows the hole punched in the hot band weld for identification.

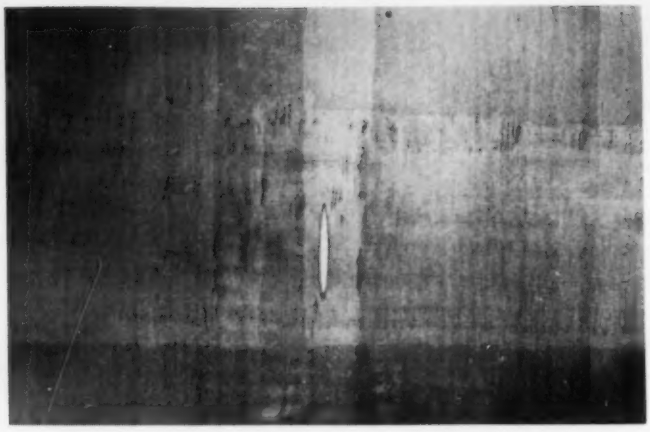


Figure 15 — After cold reduction, the elongated hole serves to identify the weld and permits it to be rejected by the pin hole detector at the shears.

grades (Figures 6 and 7) the Rockwell differential between the weld line and the parent metal is generally under the maximum 15 points recommended for good welding practice. However, on the low carbon rimmed grades the hardness differential is considerably beyond the recommended 15 point limit. This wide differential is not uncommon on the rimmed grades where the parent metal on either side of the weld may represent the steel from the top or bottom of the rimmed ingot, and the hardness values reflect the metalloid segregation characteristic of rimmed steel. Despite this high hardness differential between weld and parent metal, the welds on low carbon rimmed steel have the best performance on the cold mill.

Changes in welding practice, which have also included among other trials the delayed cut-off of welding heat, have not been successful in materially lowering the weld hardness. Some type of heat treatment after welding may be necessary to make practical a softer weld.

Many mechanical and electrical improvements relative to the mill's operation and control have been made since operations began. Not to detract from their individual or collective contributions toward increased production and better quality, the discussion in this paper will be limited to two of the developments which are thought to have contributed substantially towards the mill's success. These are concerned with the mill coolant and strip lubricant.

Filtered water pumped at 150 psi pressure is delivered against the work rolls. When originally installed the pipe type sprays discharged a greater volume of water through flattened half inch orifices. However, this set-up was not efficient, and duck-bill sprays staggered for wider and more uniform water distribution were substituted, and the orifice size was reduced to $\frac{3}{16}$ inch. This change has resulted in more effective cooling with less water volume. The split header type manifold for controlling edge and center water is now used more extensively. Split headers are installed on the bottom at the delivery side of all stands, and ahead of No. 4 and 5 stands. On the top they are used on the delivery side of No. 4 and 5 stands.

Full pressure water sprays for cooling the strip are also available top and bottom after No. 2, 3 and 4 stands. In addition to the cooling benefit of the strip sprays, the application of the strip lubricant has been improved. From these changes in water application, a greater flexibility of shape control during warm-up as well as high speed rolling has been obtained.

A unique feature of the water control system which is worthy of mention is the air pressure water guard on the delivery side of the top work roll in No. 5 stand. Because of sludge build-up, the conventional felt wiper guard was found inadequate; also, when a tear occurred in the felt after a wreck, the water drag-out onto the reel became excessive. The present guard consists of a three inch manifold with twenty-two $\frac{3}{16}$-in. air nozzles inclined toward the inside of the mill to drive the water away from the operator. Sludge build-up has been reduced, and the elimination of water drag-out to the reel has kept telescoping to a minimum.

Rolling lubricant, which for average rolling conditions is a mixture of five parts of water to one part of palm oil, is sprayed to the top and bottom of the strip ahead of No. 3, 4, and 5 stands. To prepare the mixture, four proportioning pumps, one for palm oil and three for water, feed into a 60 gallon mixing tank maintained at 170 F. The mixture from this tank is then pumped to the main loop manifold which extends the full length of the mill. From this circulating line, distributing pumps deliver the lubricant to three way valves which are located three feet from the point of application to the strip and are air operated simultaneously from a solenoid. A separate return line returns the mixture from the three-way valves to the mixing tank. This system circulates the mixture constantly when the mill is not rolling to prevent it from separating. From the three-way valves, the lubricant is fed to top and bottom manifolds where spaced flat sprays distribute it evenly across the strip width. The pumps are proportioned to the rolling speed, and the one delivering the mixture ahead of No. 5 stand is directly driven. The remaining pumps and motors have a gear reduction ratio of 6.3:1. When accelerating, the sprays turn on automatically when the delivery speed reaches 600 fpm; and, shut off when decelerating at 1000 fpm.

At first the spray nozzles had 0.062-in. orifices. However, a progressive reduction in orifice size proved successful, and at the present time an 0.026-in. orifice is being used.

Also, it has been found advantageous to eliminate the use of top spreader rolls; and on the bottom, the lubricant is sprayed after the tensiometer rolls.

REPLACEMENTS FOR PALM OIL IN COLD ROLLING STEEL

By ROBERT C. WILLIAMS
Director of Research
The Ironsides Co.
Columbus, Ohio

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Many tinplate operators will recall the rigid controls over the use of palm oil during the recent war years, and others will recall that it was taken off the market for all but essential uses.

The urgency for conserving palm oil was pointed out by Dunmire (1) * in developing his palm oil reclaiming process and by Duffy (2) in his development of a more economical and efficient application of palm oil.

Reports from the U. S. Department of Commerce show that some 30,000,000 lb of palm oil are used annually by the tinplate industry and for other metalworking applications. A large percentage of this quantity is used by tinplate operations alone. This includes not only the palm oil used in rolling but also on the tin pots and continuous pickle lines. With the progress of electrolytic tinning a decreasing proportion of palm oil has been used on tin pots.

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1. Mineral oils by direct application.
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While the use of the above types has been very successful on many cold rolling operations, no wide application has been made for rolling tinplate for various reasons.

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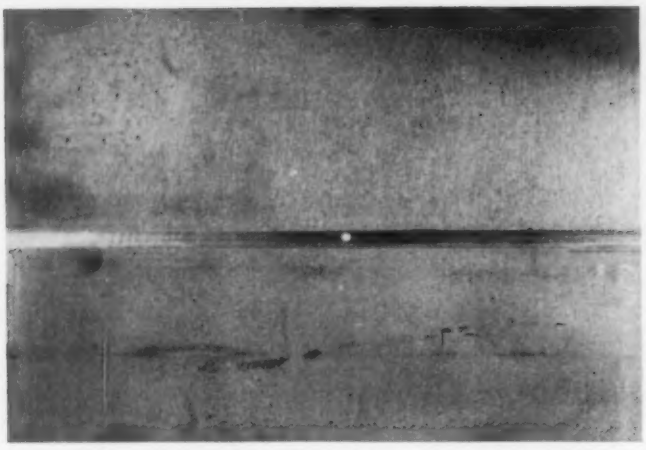

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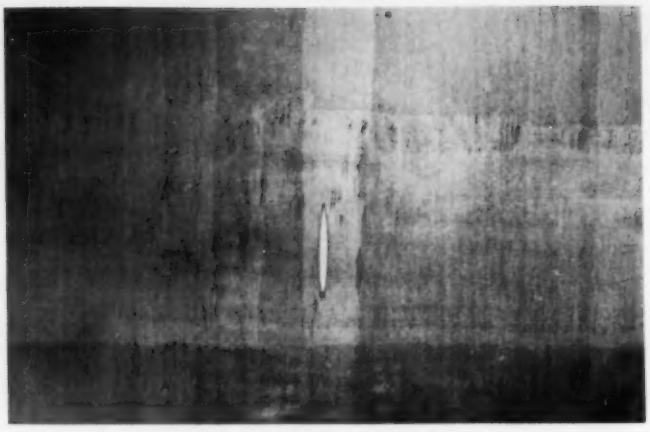

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Table I gives comparative data on palm oil and our domestic replacement designated as No. 1B. Some of the data on palm oil was taken from the latest data sheets supplied by the American Oil Chemists' Society. (5).

TABLE I

	Palm oil African-Sumatran	No. 1B
Specific gravity at 25/25 C	0.914-0.918*	0.90-0.91
Iodine value	44-54*	48-58
Saponification value	195-205*	187-195
Viscosity SUS @ 130 F	114-120	130-140
Viscosity SUS @ 210 F	53-55	56-58
Melting point	77-122 F*	90-110 F
Free fatty acid, per cent	Variable 7 to 17 range	Controlled, ±0.5

*From A.O.C.S.

The first cold rolling tests using the replacement oil were carried out on 18-8 stainless steel. Performance was satisfactory. After repeated production experience, which proved that the chemical control of the processing of No. 1B was reproducible, a trial run on rolling tinplate was proposed with reasonable confidence.

After the chemical laboratory at the steel mill had satisfied themselves that this substantially duplicated palm oil, a two hour run was made.

The replacement oil was applied to the strip at the pickle line as well as on the tandem mill. The handling throughout was the same as with palm oil. No changes in procedure were required. The results were comparable throughout. The reductions, mill loads, finish, washing, annealing, temper rolling and tinning, both electrolytic and hot dip, were comparable and satisfactory in all respects.

Following the initial run on tinplate, other trials were made with a critical analysis of the rolling and subsequent operations including the finished tinplate. During the test runs, culminated by the use of a tank car of the oil, lots having different fatty acid contents were observed for performance. No specific conclusions were drawn as to consumption or performance with fatty acid contents ranging from 8 to 14 per cent.

CONTROLLED FREE FATTY ACID CONTENT

The free fatty acid content of the No. 1B can be controlled to plus or minus 0.5 per cent at the request of the mill supervision. It will be readily appreciated that experimenting with lots of lubricant having extremes in free fatty acid content could be an expensive gamble when dealing with production mills. No performance data is therefore available to date regarding lots having free fatty acid contents of less than 8 or more than 14 per cent.

FURTHER TESTS AND USE

As a result of the early successful mill tests, this oil has been now tested or is in use in a majority of the tinplate mills in this country and Canada. Regular production has reached a substantial figure. Tests have been made involving all forms of application: direct, solution and proportioning-pump mixing with water. Results have been uniformly good and in some cases superior to palm oil. It is believed that uniformity of the material made with customer specified free fatty acid content, eliminates variables in performance which are occasionally encountered with palm oil. Experience in some mills has shown lower consumption as compared with palm oil, gauge is reached sooner on starting up and shape is held better. Tonnage increases have not been uncommon.

It is probable that further improvements will be made, since it is hardly possible that natural palm oil could have all the virtues of the ultimate in rolling lubrication. The engineering advances in cold rolling always keep the ultimate ahead.

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4. *"Lubricants for Cold Rolling Steel,"* by R. J. Nekervis and R. M. Evans, 1948 Proceedings of the AISE, p 752.
5. *"Official Methods,"* 1950 Revision, Table I, 1-46, p 3, American Oil Chemists' Society.

DISCUSSION

PRESENTED BY

ALLEN BROWN, Pittsburgh, Pa.

D. E. WHITEHEAD, General Lubrication Engineer, Crucible Steel Co. of America, Pittsburgh, Pa.

W. J. BROWN, Lubrication Engineer, Weirton Steel Co., Weirton, W. Va.

ROBERT C. WILLIAMS, Director of Research, The Ironsides Co., Columbus, Ohio.

L. F. COFFIN, Superintendent Mechanical Department, Bethlehem Steel Co., Sparrows Point, Md.

R. J. NEKERVIS, Supervisor Metallurgical Development, Tin Research Institute, Inc., Columbus, Ohio.

R. G. LEISTER, Lubrication Engineer, Alan Wood Steel Co., Conshohocken, Pa.

Allen A. Brown: Mr. Williams, in discussing palm oil replacements, has confirmed an earlier statement that improvements can be made by cooperation with practical application of the fundamentals of lubrication. Once we discard the idea that certain products, whether they be compounded or naturally produced, are endowed with magic powers and evaluate them using fundamentals and sound reasoning, we are going to move ahead in our particular field.

The feature of domestic production with man-made controls is a very definite advantage, and once the reluctance to study such products is overcome, still further progress may be made, fully utilizing the funda-

mentals of lubrication and fatty materials. For years, many operations in tin mills have been tailored to meet palm oil requirements and now that advances have been made in recent years in the use of domestic palm oil replacements, it might be well worth while restudying the fundamentals of lubricating such operations and possibly investigating the use of a variety of fatty based products.

D. E. Whitehead: However, in the processing of alloy steel there are, as the author has suggested, operations in which palm oil is indicated for cold rolling alloy steel strip and sheet stock. The new large Crucible strip and sheet alloy cold mills have never used palm oil, having commenced operation at a time when we considered that there were established "replacements for palm oil" that were more attractive to us for the specific applications involved.

There are many "replacements for palm oil" that have demonstrated equal or superior abilities for the actual reduction of metal but of these some are necessarily discarded because of:

1. Problems they cause or contribute to in the subsequent furnace annealing of the strip or sheet.
2. Fire hazards incited by the excessive volatility of the blended ingredients of the "replacement for palm oil."
3. Instability of the blended oils that present problems in the form of separation of ingredients, objectionable odor, difficulties in obtaining fixed blends, high pour points and/or excessive thermal sensitivity, difficulty in fixing pH values and fatty acid content, oxidation and bacteria problems, toxicity, and thermal breakdown.
4. There are forms of animal derived fatty oils applicable as "replacements for palm oil" that in certain forms are too contaminated to permit initial use or to be retained in long service.
5. There are blends of oils that present an accumulative problem from the standpoint of films formed on the rolls.
6. Problems in control of film type and thickness required to gain desired finish lustre.
7. Non-uniformity of spread and metal surface wetting capacity.
8. Difficulties of filtering or settling out contaminants to permit reuse of some blends of oils.

While all of the foregoing tends to make it appear that the better course might be to forget the problems entailed in the trials of "replacement for palm oil" there are the following worthwhile inducements to compensate efforts:

1. Marketing problems contingent to palm oil procurement, i.e., import problems, war shortages, cost fluctuations, specification irregularities.
2. The probability of developing a blend of fatty oils that will permit worthwhile improvements in ease of reduction of metal, better surface finish, gauge uniformity, a highly stable roll oil, reduction in roll oil cost, and confronted with stream pollution problems as they are manifest today, a lessening of frequency in the problem of disposal of discarded roll oils.

W. J. Brown: As the Weirton Steel Co. at Weirton, W. Va. is the largest independent producer of tinplate in the world, we feel that with the years of rolling experience with palm oil and palm oil substitutes, that we can comment on Mr. Williams' talk with some authority.

Mr. John McPhee, of the author's company, approached us with their palm oil substitute a few months ago. His specifications of this oil looked favorable but their trials limited to slower mills than our 4-high cold mills. Our production is so closely netted that it would be extremely dangerous for trials on our tandem mills. We felt that we should not make a trial until it had been proven on mills that were similar to ours.

With this short resume, I want to ask Mr. Williams if trials have been made on mills that roll tinplate at speeds approaching our 4-high, 5-stand tandem cold mill that rolls in the vicinity of a mile per minute? If so, did you find an excessive mill load? Was the consumption of oil per ton similar to the consumption of palm oil?

You mentioned in your talk that a trial had been made on cold reducing mills but you did not mention their operating conditions. I would like these questions answered more thoroughly so that I may issue something that may initiate a trial of your oil.

Robert C. Williams: I do not have the exact figures but I think I can give you a little guide. One head roller may use more of it than the next one. In direct application it depends on how hard they are hitting the steel, what their entering gauge is, etc. The figures run from 2 to 4 or 5 lb per ton. On solution rolling, some of it is pumped off and thrown away, as you know, and the overall consumption may run from slightly less than one pound per ton up to about two pounds per ton. These are round figures. Individual operators may use more or less.

Regarding rolling speeds, our oil has been used on mills hitting speeds of the order of 4000-4200 fpm. The mill loads were normal and the operators were pleased with the results. Regarding rolling at a mile per minute, we believe the oil will do it if palm oil will do it.

L. F. Coffin: I would like to ask Mr. Williams to discuss the reclamation of his product as compared to methods in use for the reclamation of palm oil. I would also like to ask as to the reliability of the availability of his products. Are they made from domestic products which will be available in time of war?

Robert C. Williams: In answer to the last question, I have government bulletins for many years, showing the production of all of the vegetable and animal fats in this country, and they are truly staggering figures. They are measured in billions rather than in millions of pounds and the flexibility of the product is such that you would not be restricted to any one of them. I would say even under extreme war conditions, supposing this thing did go over pretty well, we could get a little government help on allocation, if necessary. We are not worried about that sort of thing.

Regarding reclaiming, the only reclaiming that we watched has been done by a process which is used by Wheeling Steel. I think it is a fair statement to say that the reclamation was on an even basis for that of palm oil. Regarding the settlings and skimmings, as you refer to them, we have done no reclamation on those. Whether some of our customers have marketed those through their regular channels, I do not know. I assume they may have.

I will say this. I have checked the settlings and skimmings and the analysis is quite similar to that of palm oil. As you know, the various settlings are pretty well charged with mill dirt, oxide, etc., and the analysis on that is remarkably uniform from one mill to another. By that I mean you get enough weight built into that stuff so it can settle. You have to have a moderate percentage in there to overcome the natural specific gravity of fatty material itself. The analysis may show up to 22 to 30 per cent foreign, inorganic matter. When somebody is going to reclaim that, he is going to have to get that much dirt out of our stuff as well as out of the other. I do not have any good, clear-cut differential analysis between stuff that may float and what may sink.

Robert Nekervis: I should like to emphasize that Dr. Williams is quite right in pointing out that he has developed a lubricant which is very satisfactory as a replacement for palm oil for cold rolling tinplate stock.

However, I should also like to point out that the data given in his Table I does not necessarily bear any relationship to good performance as a lubricant. Indeed, so far as new developments are concerned, they are about as helpful as a whipsocket on a roadster. Dr. Williams, I know, knows this, but there are some operators who do not; and, therefore, there is always a danger of these specifications being placed on a new lubricant.

When A. J. Castle discovered the excellent lubricating properties of palm oil back in 1930, he was at his wit's end trying to obtain reduction to tinplate gauges in the five passes afforded him on the new five-stand tandem mill. Several of the larger oil companies were consulted on this, but none of the mineral oil combinations they suggested came even close to furnishing the friction reduction necessary to do the job in five passes. Mr. Castle tried palm oil because it felt slippery between his fingers, and this test crude as it is, is infinitely better than adhering to any of the specifications mentioned in the paper. Time does not permit me to go into detail on this, but let me cite one example.

Take the limitation on free fatty acid. I note from the paper that an 0.5 per cent fatty acid limitation was requested by the mill supervision. This limitation, I think, comes from the fact that the acids in palm oil are hard, and if present in large amounts, cause roll slipping. Now this is not necessarily true with all acids. Oleic acid has been used neat with results that compare favorably with palm oil. I expect that, if Mr. Castle tried red oil, that is, a cheap, impure grade of oleic acid, instead of palm oil on that fatal day at Wheeling, we might have another set of limitations on new lubricants which are equally remote from the business at hand.

I hope that these few notes have shown the need for caution where specifications on new lubricants are concerned. I feel that Dr. Williams' paper did not stress this sufficiently.

Robert C. Williams: Mr. Nekervis said that he might not be here and told me some of his notes, and I agreed with what he says. His emphasis is correct. It calls to mind one thing that I have been told by mill operators, one reason they do not like excessive fatty acid content is that it fouls up their washers. Sometimes it becomes converted into soap by the alkalinity in their washers, and I suspect that certain operators would not like straight oleic acid on their mill, although that might roll in pretty good shape.

Robert J. Nekervis: Dr. Williams is correct in his statement on the effect of organic acids on the sodium orthosilicate solutions in present use. These solutions cannot tolerate more than about 3-4 per cent of soap. Substantial amounts of dragout permit the acid content of the oil to be higher than this. The higher the cleaner speed, the greater the amount of dragout and the greater the tolerance for acid in the lubricant. However, red oil probably would not require as strong an alkali for cleaning as palm oil; soda ash or trisodium phosphate probably would be satisfactory for removing it. I have not had occasion to try it. Perhaps the removal of associated non-oily material would require some modification. In any case, satisfactory cleaning could be achieved.

Perhaps I should have picked another material of different structure which would clean satisfactorily in existing cleaners as an example. A number of glycerides, esters, and higher alcohols come to mind which proved to be satisfactory lubricants for tinplate stock. These would not necessarily fit the various palm oil specifications, but would, I feel sure, be satisfactory in most, if not all other respects. Indeed, there is room for improvement in many respects. For example, palm oil and other fatty oils cause dewetting in subsequent hot tinning operations if small amounts are not removed and are baked on the strip in the annealers. Other suitable lubricant materials for tinplate stock are satisfactory in this respect.

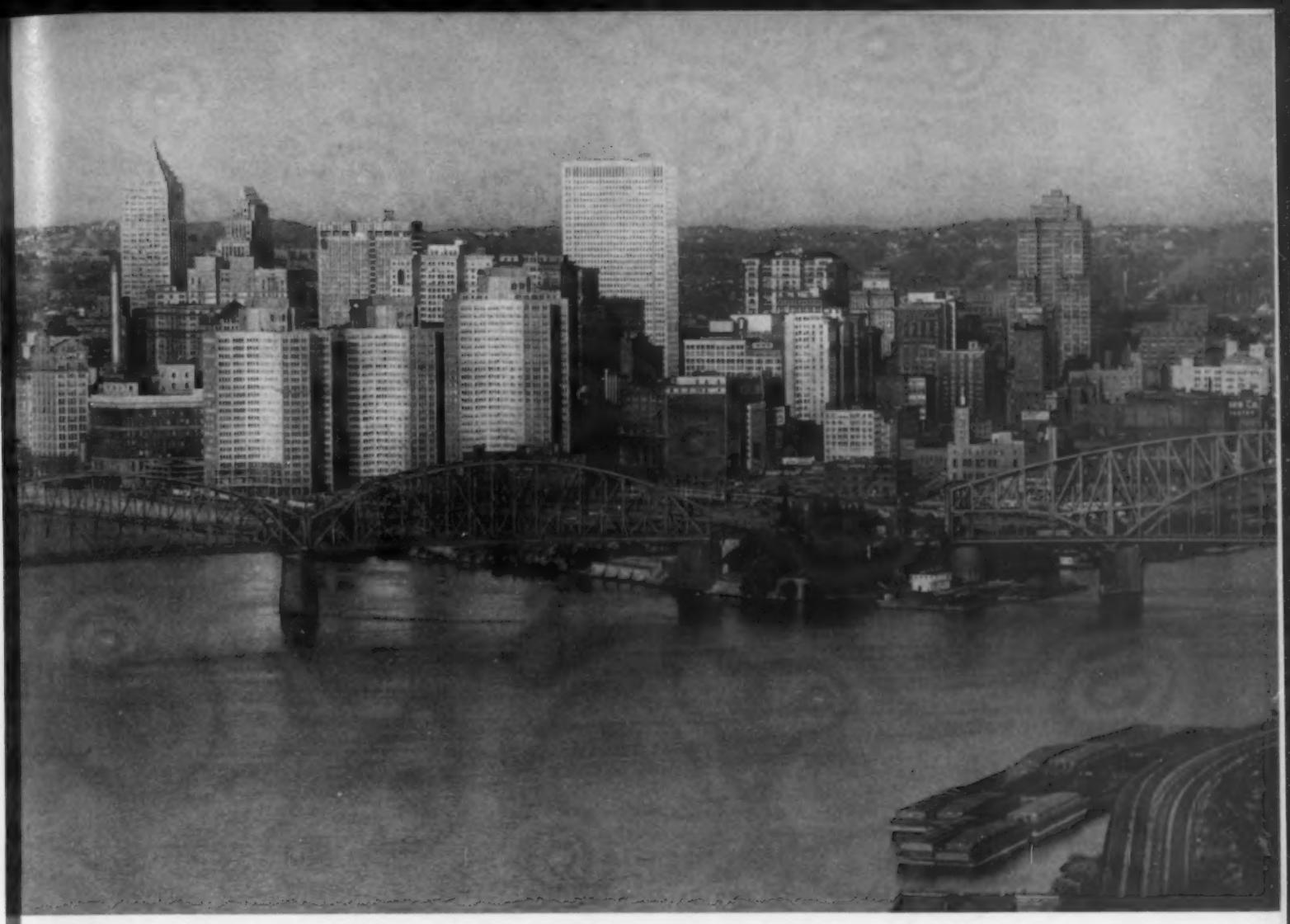
R. G. Leister: One usage of palm oil and/or palm oil substitutes not covered by Mr. Williams in his paper is that of grinding and polishing stainless steel sheets. In general, this type of work is done on endless belt type grinding machines at relatively high belt speeds.

Palm oil has been utilized almost exclusively for both rough grinding and finish grinding operations for several years. Various admixtures, utilizing palm oil as the basic ingredient, have been compounded by the individual operations in keeping with their own field experiences. Palm oil has also been used in the neat form for the finishing grinding operations, being applied in a heated state for ease of application.

Recent field tests have been made throughout the steel industry which have resulted in the development of substitute material both of the fatty acid and compounded mineral oil types. In most cases these detailed studies have offered saving in operating costs and added benefits such as reduced smoking of the oil, better belt life, lower grinding temperatures, etc.

Development of specific formulations wherein effective control of fatty acid type and content was forthcoming in addition to viscosity, volatility, etc., has offered the so-called "tailor made" oils for this field of application. Oils of this type can be made to the desired degree of consistency and content for each successive batch which in turn eliminates the many variables encountered heretofore due to lack of oil compatability.

It is believed that continued study of this type operation will undoubtedly offer definite improvements in the future as to the types of oil used and method of application. A new type of belt material currently being tested gives an added reason for obtaining additional information and experience in this regard.



ASSOCIATION OF IRON AND STEEL ENGINEERS

1953 Annual Convention

WILLIAM PENN HOTEL
PITTSBURGH, PA.

SEPTEMBER 28, 29, 30, OCTOBER 1

Program

ASSOCIATION OF IRON AND STEEL ENGINEERS

1953 CONVENTION

WILLIAM PENN HOTEL

PITTSBURGH, PENNSYLVANIA

September 28, 29, 30, October 1

Monday, September 28

9:00 am — REGISTRATION — Fort Duquesne Room

9:15 am — BUSINESS MEETING — Urban Room

Conducted by President John L. Young

9:30 am — OPERATING PRACTICE SESSION— Monongahela Room

Chairmen: George Greene, Assistant General Manager, Bethlehem Steel Co., Johnstown, Pa.

P. E. Thomas, Assistant General Superintendent, United States Steel Corp., Gary, Ind.

"The Impact of Technological Developments in the Light Flat Rolled Steel Process on the Consuming Industries," by William T. Hogan, S. J., Professor of Economics, Fordham University, New York, N. Y.

"Scrap Preparation and Scrap Contamination," by Robert F. Kuhnlein, Superintendent of Construction, Sheffield Steel Corp., Kansas City, Mo.

"Modern Underground Coal Mining," by R. H. Knapp, Chief Engineer—Coal, United States Steel Corp., Pittsburgh, Pa.

9:30 am — ELECTRICAL SESSION — Urban Room

Chairmen: K. L. Johannsen, Division Superintendent Maintenance and Utilities, United States Steel Corp., Morrisville, Pa.

Robert S. Bogar, Assistant to General Manager, Bethlehem Steel Co., Bethlehem, Pa.

"Grounded versus Ungrounded Low-Voltage A-C Systems," by H. B. Thacker, Distribution Engineer, Industry Engineering Dept., Westinghouse Electric Corp., East Pittsburgh, Pa.

"Cathodic Protection of Mill Grounding Systems," by J. F. Headlee, Electrical Design Engineer, Construction Engineering Bureau, United States Steel Corp., Fairless Hills, Pa.

"Integrated Electrical Equipment for Blast Furnaces," by C. P. Hamilton, Application Engineer, General Electric Co., Schenectady, N. Y.

2:00 pm — MECHANICAL SESSION — Monongahela Room

Chairmen: F. E. Robinson, Assistant Division Engineer, American Steel & Wire Div., United States Steel Corp., Cleveland, Ohio.

E. C. Hite, Assistant Superintendent Maintenance, Timken Roller Bearing Company, Canton, Ohio.

"Foundation Design for Iron and Steel Plants," by G. S. Richardson, Consulting Engineer, Pittsburgh, Pa.

"Water Supply for Steel Plants," by Ross Nebolsine, President, Hydrotechnic Corp., New York, N. Y.

"Ultrasonics in Maintenance Planning and Product Quality Control," by R. L. Rectenwald, President, Maintenance Engineering Corp., Pittsburgh, Pa.

2:00 pm — OPEN HEARTH SESSION — Urban Room

Chairmen: G. H. Krapf, Assistant Chairman — Fuel and Power Committee, United States Steel Corp., Pittsburgh, Pa.

E. H. Cauger, Chief Combustion Engineer, Wheeling Steel Corp., Steubenville, Ohio.

"Improved Cleaning Techniques for Open Hearth Checkers," by J. J. Enochs, Sales Engineer, Dowell, Inc., Wilmington, Del. and Reece Kincaid, Sales Engineer, Dowell, Inc., Chicago Heights, Ill.

"Cleaning of Open Hearth Checkers and Sewers During Operation," by Robert M. Jordan, Assistant Superintendent No. 3 Open Hearth, Bethlehem Steel Co., Lackawanna, N. Y.

"Republic's New Open Hearth Furnaces at Cleveland," by E. C. McDonald, Superintendent, Combustion Dept., Republic Steel Corp., Cleveland, Ohio.

"New Open Hearth Furnaces at Stelco," by E. T. W. Bailey, Chief Combustion Engineer, The Steel Co. of Canada, Ltd., Hamilton, Ontario, Canada.

9:30 pm — PRESIDENT'S RECEPTION AND INFORMAL DANCE — Urban Room

AISE members and guests. No admission charge.

Tuesday, September 29

9:00 am — BLAST FURNACE REFRACTORIES SESSION — Urban Room

Chairmen: C. G. Hogberg, Assistant Chairman — Blast Furnace Committee, United States Steel Corp., Pittsburgh, Pa.

J. A. Bell, Chief Engineer, Bethlehem Steel Co., Bethlehem, Pa.

"Temperature Distribution in the Hearths of Blast Furnaces," by Professor V. Paschkis, Technical Director, and Taghi Mirsepassi, Research Engineer, Heat and Mass Flow Analyzer Laboratory, Columbia University, New York, N. Y.

"Trends in Blast Furnace Linings," by Hobart M. Kraner, Ceramic Engineer, Bethlehem Steel Co., Bethlehem, Pa.

"Bricklaying as a Factor in the Performance of Blast Furnace Linings," by W. S. Debenham, Research Associate, Research and Development, United States Steel Corp., Pittsburgh, Pa.

9:00 am — LUBRICATION SESSION — Monongahela Room

Chairmen: C. A. Bailey, Lubrication Engineer, National Tube Div., United States Steel Corp., Pittsburgh, Pa.

Andrew E. Cichelli, Lubrication Engineer, Bethlehem Steel Co., Bethlehem, Pa.

"Activated Alumina for the Maintenance of Gas Engine Crankcase Oils," by Lowrie B. Sargent, Jr., Assistant Chief, and E. M. Kipp, Chief, Lubricants Division, Aluminum Research Laboratories, Aluminum Co. of America, New Kensington, Pa.

"Oilless Bearings — Their Place in Industry," by Charles D. Spadone, Vice President, Spadone-Alfa Corp., New York, N. Y.

"Application of Bronze Bearing Alloys," by James L. Duchene, Sales Representative, National Bearing Division, American Brake Shoe Co., Pittsburgh, Pa.

"Laminated Fabric Bearing Materials," by Richard L. Berry, Manager, A-B-K Sales, American Brakeblok Division, American Brake Shoe Co., Detroit, Mich.

2:00 pm — MATERIALS HANDLING SESSION — Monongahela Room

Chairmen: Carleton Lord, Materials Handling Engineer, United States Steel Corp., Pittsburgh, Pa.

M. D. Ayers, Chief Engineer, Wheeling Steel Corp., Wheeling, West Va.

"Imported Ore Handling — Machines and Practices," by Erle M. Hays, Sales Engineer, Crane & Bridge Dept., Engineering Works Division., Dravo Corp., Pittsburgh, Pa.

"Intraplant Handling of Round Billets and Pipe with Special Automotive Equipment," by J. D. Tyson, Superintendent, Warehousing and Shipping Dept., National Tube Division, United States Steel Corp., Lorain, Ohio.

"Application of Self-Centering Rolls for Strip Processing Lines," by E. T. Lorig, Chief Development Engineer, United States Steel Corp., Pittsburgh, Pa.

2:00 pm — ELECTRICAL SESSION — Urban Room

Chairmen: D. C. McCrady, Superintendent Electrical Dept., Steel Co. of Canada, Ltd., Hamilton, Ontario, Canada.

R. T. Lucas, Electrical Superintendent, Weirton Steel Co., Weirton, West Va.

"System Engineering for Continuous Strip Processing Line," by J. S. Apperson, Steel Mill Engineering, Industrial Engineering Section, General Electric Co., Schenectady, N. Y.

"Temper Mill Control," by George P. Dirth, Electrical Engineer, Granite City Steel Co., Granite City, Ill.

"Estimating Motor Room Installation Costs," by Wray Dudley, Chief Consulting Engineer, Patterson-Emerson-Comstock, Inc., Pittsburgh, Pa.

"Crane Power Limit Switches," by Robert W. Graham, Superintendent Electrical Dept., Bethlehem Steel Co., Lackawanna, N. Y.

6:00 pm — OLD TIMERS DINNER — Urban Room

Wednesday, September 30

9:00 am — ELECTRIC FURNACE SESSION — Urban Room

Chairmen: A. K. Blough, Superintendent No. 2 and 3 Melt Shops, Republic Steel Corp., Canton, Ohio.

Robert Sergeson, Chief Metallurgical Engineer, Rotary Electric Steel Co., Detroit, Mich.

"Growth Possibilities of Electric Furnace Carbon Steel," by W. C. Wheeler, Management Consultant, New York, N. Y.

"Cost Comparisons of the Open Hearth and Electric Furnace," by David D. Moore, Assistant Supervisor, Engineering Economics Division, Battelle Memorial Institute, Columbus, Ohio.

"The Future of Large Electric Furnaces Compared to Modern Open Hearths," by Frank W. Brooke, Pittsburgh, Pa.

9:00 am — ROLLING MILL SESSION — Monongahela Room

Chairmen: Alex Montgomery, Jr., Assistant to Vice President—Rolling, United States Steel Corp., Pittsburgh, Pa.

J. N. Imel, Superintendent Sheet and Strip Dept., Jones and Laughlin Steel Corp., Pittsburgh, Pa.

"The Direct Rolling of Carbon Steel Ingots to Plates on Three High and Four High Plate Mills," by Robert C. McMichael, Supervisor 112-120-in. Mills, Lukens Steel Co., Coatesville, Pa.

"Recent Advancement in Continuous Butt Weld and Induction Weld Pipe Mills," by William Rodder, Vice President Engineering, Aetna-Standard Engineering Co., Pittsburgh, Pa.

"Temperature Gradients and Stresses in Iron Work Rolls," by Charles F. Peck, Jr., Assistant Professor Civil Engineering, Carnegie Institute of Technology, Pittsburgh, Pa.

2:00 pm — COMBUSTION SESSION — Monongahela Room

Chairmen: G. J. Gockstetter, District Combustion Engineer, Republic Steel Corp., Chicago, Ill.

A. F. Kritscher, Assistant Chief Engineer, Process Development, National Tube Div., United States Steel Corp., Pittsburgh, Pa.

" Progress in the Development and Application of Metallic Recuperators in the Steel Industry," by E. A. Vierow, Superintendent, Fuel and Power Dept., Youngstown Sheet & Tube Co., Youngstown, Ohio.

"New Soaking Pit Facilities at Ford Motor Co. Steel Division," by B. D. Barns, Supervisor, and H. E. Raafloub, Senior Fuel & Utilities Engineer, Fuel & Utilities Dept., Steel Div., Ford Motor Co., Dearborn, Mich.

"Heat Processing in Industry — Facts and Figures," by Frederic O. Hess, President, Selas Corp. of America, Philadelphia, Pa.

2:00 pm — ELECTRICAL SESSION — Urban Room

Chairmen: F. H. Wickline, Electrical Engineer, National Tube Div., United States Steel Corp., Pittsburgh, Pa.

George A. Kaufman, Chief Electrical Engineer, Jones and Laughlin Steel Corp., Pittsburgh, Pa.

"Modern Arc Furnace Equipment and Practices," by E. H. Browning, Steel Mill Engineer, Metal Working Section, Westinghouse Electric Corp., East Pittsburgh, Pa.

"The Determination of Optimum Current in an Arc Furnace," by W. E. Schwabe, Research Engineer, National Carbon Research Laboratories, Cleveland, Ohio.

"Problems in Supplying Power to Electric Furnaces," by George E. Duerr, Industrial Sales Manager, West Penn Power Co., Pittsburgh, Pa.

7:00 pm — FORMAL DINNER — Ball Room

10:00 pm — DANCE — Urban Room

AISE members and guests. No admission charge.

Thursday, October 1

9:00 am — COMBUSTION SESSION — Urban Room

Chairmen: F. B. Bevelheimer, Power and Fuel Engineer, Ford Motor Co., Dearborn, Mich.

R. A. Lambert, Superintendent Steam and Combustion, Jones and Laughlin Steel Corp., Pittsburgh, Pa.

"Studies on Provision and Use of Oxygen in Steel Plants," by Glen O. Carter, Partner, Percival R. Moses & Associates, Consulting Engineers, New York, N. Y.

"Use of Plastic, Castable, and Gunning Materials in Soaking Pits," by W. D. Rees, Superintendent, Bar and Blooming Mill, Sharon Steel Corp., Lowellville, Ohio.

"Combination Fuel Firing for High Pressure Boilers," by C. J. Webster, Fuel Engineer, National Tube Division, United States Steel Corp., McKeesport, Pa.

9:00 am — LUBRICATION SESSION — Monongahela Room

Chairmen: D. E. Whitehead, General Lubrication Engineer, Crucible Steel Co. of America, Pittsburgh, Pa.

W. M. Schuck, Lubrication Engineer, Armco Steel Corp., Middletown, Ohio.

"Factors Affecting the Performance of High Temperature Greases," by Eldon L. Armstrong, Research Associate, Socony-Vacuum Laboratories, Technical Service Dept., Brooklyn, N. Y.

"Pumpability of Steel Mill Grease," by Joseph S. Aarons, Lubricants Chemist, National Tube Div., United States Steel Corp., Pittsburgh, Pa., Richard G. Warren, Lubrication Engineer, United States Steel Corp., Homestead, Pa., and J. J. Seaton, Laboratory Technician, National Tube Div., United States Steel Corp., Pittsburgh, Pa.

"Steel Mill Lubrication Problems," by A. C. Keiser, Jr., Supervising Lubrication Engineer, The Texas Co., Birmingham, Ala.; E. E. Perso, Supervising Lubrication Engineer, The Texas Co., Los Angeles, Calif.; W. H. Mandy, Engineering Representative, The Texas Co., New York, N. Y.; and M. S. Clark, Chemist, Technical and Research Div., The Texas Co., New York, N. Y.

1:30 pm — INSPECTION TRIP TO PITTSBURGH WORKS, JONES & LAUGHLIN STEEL CORP.

This trip will include the open hearth shop, and blooming mill, as well as the strip mill.

Ladies Program

MONDAY, September 28

9:00 am — Ladies Registration — Parlors E - F, William Penn Hotel
3:00 pm — Welcome Party — Women's City Club, William Penn Hotel
9:30 pm — President's Reception and Informal Dance — Urban Room, William Penn Hotel

TUESDAY, September 29

12:30 pm — Luncheon — Pittsburgh Field Club — Buses will leave William Penn Hotel at 11:00 am. (Ladies meet in Parlors E - F, William Penn Hotel)

WEDNESDAY, September 30

7:00 pm — Formal Dinner — Ballroom, William Penn Hotel
10:00 pm — Dance — Urban Room, William Penn Hotel

Honorary Chairwoman — Mrs. J. L. Young *General Chairwoman* — Mrs. F. S. Bloom
Vice Chairwoman — Mrs. C. H. Williams

To partially cover costs, a flat registration charge of $5.00 will be made which will cover all ladies' activities except the formal dinner on Wednesday evening. This must be paid on registering, when tickets will be issued for these events.

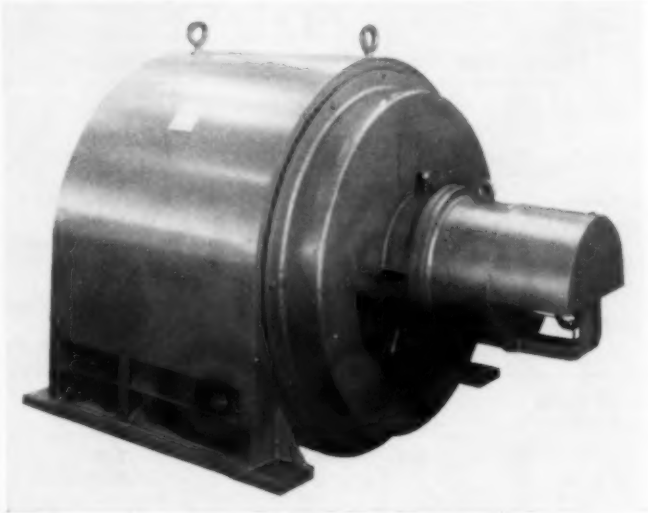
SYNCHRONOUS MOTOR TORQUE REQUIREMENTS FOR STEEL MILL APPLICATIONS

By DR. WILLIAM A. THOMAS
Chief Engineer
The Electric Products Co.
Cleveland, Ohio

. . . . synchronous motors should receive serious consideration in all applications except small sizes . . . .

▲ EVERY steel mill has numerous synchronous motors in use. These motors give excellent service along with high power factor and excellent efficiency. But are they being used to the fullest extent they are capable of, especially on applications of severe and exacting duty? This type of motor has been continually improved so that it now challenges the induction motor for all applications except the small sizes. The reason for this rests in improved insulation due both to materials and techniques, in more dependable materials throughout and rugged mechanical design. Enclosures of all types such as dripproof, splashproof, separate ventilation, totally enclosed and outdoor weatherproofed are being used. Stators have always been almost duplicates of induction motor stators, but now even field constructions are being built just as trouble-free. Excitation systems have been improved with direct-connected exciters, electronic rectifiers, dry type rectifiers and now magnetic amplifiers.

Figure 1 — The synchronous motor is ruggedly built. This unit is designed for high speed.



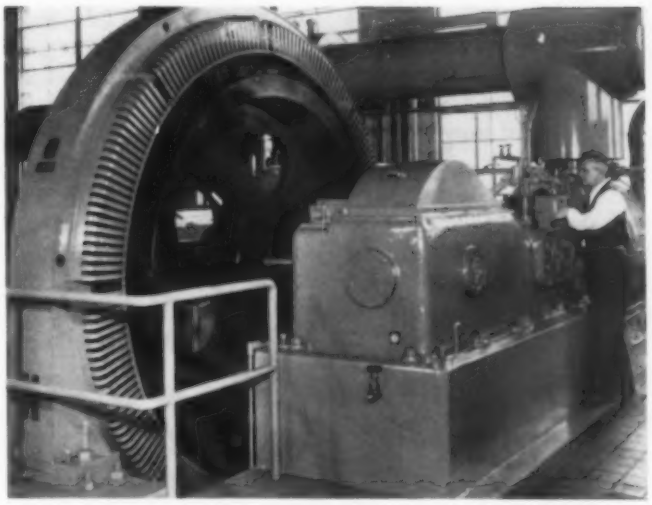


Figure 2 — This synchronous motor is designed for low speed operation.

Not alone in the machine itself, but also in the control, have simplifications been made. Present day synchronous motor starters with the modern field application relays are dependable, simple and rugged. Synchronous motors have been applied to drives such as chippers, crushers and rolling mills, which are as severe as any job motors are called upon to do. Figures 1, 2 and 3 are typical of modern construction.

When applying synchronous motors to unusual loads which require special torques, the ability of the motor designers also is challenged to put these torques into the machines with no loss in the traditional qualities of the type. Improvements in the calculation methods have made it possible for engineers to closely predict the torque performance of their synchronous motors and thus realize their desires for the best job.

It is the purpose of this paper to briefly review the methods of obtaining synchronous motor torques and what torques various applications may require. It is

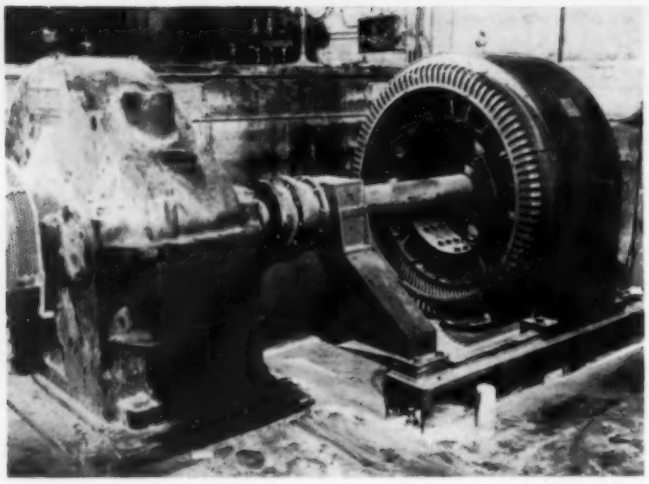


Figure 3 — This synchronous motor is of double cage construction.

hoped that such a review will assist users to more closely anticipate their needs and for the designers to more closely furnish the requirements. In this way perhaps we can apply synchronous motors to more applications and obtain both higher efficiency and power factor improvement. Such advantages are important in the interest of lowering the cost of power.

The American Institute of Electrical Engineers and the National Electric Manufacturers Association both specify three torque requirements for synchronous motors. In the interest of simplification it is felt that the three cardinal values of starting torque, pull-in torque and pull-out torque adequately define a load requirement. This obviates the necessity for a complete sub-synchronous torque-speed curve. In other cases knowledge of the application is limited and these three values are all that can be decided upon. In general they are adequate.

Starting torque or locked rotor torque is well known by engineers. It is the locked rotor torque at normal voltage. Adequate attention to line voltage must be made to keep this value at rated value. From an application viewpoint it is also the torque required to start the load moving.

The nominal pull-in torque is by definition the torque at 95 per cent synchronous speed. It is important here to realize that nominal pull-in is at 95 per cent speed on the starting winding and not the value when the motor pulls into step. Depending on many things such as WR_2, load requirement, synchronizing torque and damping torques, motors may pull in anywhere from 90 to 97 per cent speed or sometimes lower. Since the torque characteristics drop rapidly as synchronous speed is approached, there may be applications where adequate pull-in torque is available but the motor will not synchronize. Whether a difficult application will synchronize is a subject requiring special study.

It is at the pull-in point that the design of the control equipment is important. The field must be applied after the machine is up to speed, after field excitation is available and at the instant when the field structure is in the correct angular position. Simple relays are available to do this job. Sometimes the motor has adequate torque but the field control is at fault. If the machine does not synchronize when the field is applied, the actual torque is greatly reduced and the unit may fail to pull-in.

Although not defined by NEMA, but sometimes equally important in applications, is the accelerating torque. The accelerating torque must be available over and above the load requirements to bring the motor from the start to the pull-in point. In close designs there may be a critical value at one half synchronous speed. Some knowledge of these requirements is usually needed.

Pull-out torque is the maximum torque available in synchronous operation with normal voltage and field excitation. This is the torque available to carry the load under normal conditions when the machine is running at normal speed. This is in contrast to starting and pull-in which are at sub-synchronous speed.

The National Electric Manufacturers Association standard torques for 60 cycle synchronous motors are given in Table I.

The American Institute of Electrical Engineers spe-

TABLE I

NEMA MG 1 — 8.14, 8.28, 8.41
General Purpose Motors — 60 Cycle

Power factor and horse power	Speed	Torque		
		Locked-Rotor	Pull-In	Pull-Out
1.0 pf up to 200 hp	1800	110	110	150
	1200-514	110	110	175
0.8 pf up to 150 hp	1800	125	125	200
	1200-514	125	125	250
Large High-Speed Motors — 60 Cycle				
1.0 pf 250-500 hp	1800-514	110	110	150
0.8 pf 200-500 hp	1800-514	125	125	200
1.0 pf 600 hp and larger	1800-514	85	85	150
0.8 pf 600 hp and larger	1800-514	100	100	200
Low Speed Motors — 60 Cycle				
1.0 pf	Up to 450	40	30	150
0.8 pf	Up to 450	40	30	200

TABLE II

AIEE — C-50 — Torques

General Purpose Motors — 60 Cycle

Power factor and horse power	Speed	Locked-Rotor	Pull-In	Pull-Out
1.0 pf to 200 hp	1800	110	110	150
	1200-514	110	110	175
0.8 pf to 150 hp	1800	125	125	200
	1200-514	125	125	250
Large High Speed — 514 rpm and Up — 60 Cycles				
1.0 pf 250-500 hp	1800-514	110	110	150
0.8 pf 200-500 hp	1800-514	125	125	200
1.0 pf 600 hp and up	1800-514	85	85	150
0.8 pf 600 hp and up	1800-514	100	100	200
Low Speed — 450 rpm and Larger — 60 Cycle				
1.0 pf	.....	40	30	150
0.8 pf	.....	40	30	200

cifications for normal torques for 60 cycle general purpose motors follows in Table II.

There is always the question of definition of a general purpose motor which NEMA covers only by reference to standard temperature requirements. In order to cover specific applications NEMA also gives a list of suggested torque requirements. These range from:

Locked motor..... 40-200 per cent torque
Pull-in..... 30-150 per cent torque
Pull-out..... 150-300 per cent torque

TABLE III

Synchronous Motor Torque Requirements

NEMA MG 1.89

Application	Starting Condition	Per cent Torque		
		Starting	Pull-in	Pull-out
Ball mills				
Rock and coal	Mill loaded	150	110	150
Ore	Mill loaded	175	110	175
Blowers, centrifugal	Valves closed	40	60	150
	Valves open	40	100	150
Blowers, rotary	By-passed	40	40	150
Bowl mill, (Coal pulverizer)	.....	150	125	150
Compressor, centrifugal	Valves closed	40	60	150
	Valves open	40	100	150
Compressor, fuller	Unloaded	60	30	150
	Loaded	60	100	150
Compressor, reciprocating				
Air and gas	Unloaded	40	30	150
Ammonia	Unloaded	40	30	150
Freon	Loaded	40	50	150
Crushers	Unloaded	100	100	250
Fans, centrifugal	Valves closed	40	60	150
	Valves open	40	100	150
Fans, propeller	Closed	60	100	150
Fans	Open	40	100	150
Generators (M-G sets)	.....	40	30	200
Generators (electroplating)	.....	40	30	150
Pumps, centrifugal	Valves closed	40	60	160
	Valve open	40	100	150
Pumps, centrifugal				
Vertical	Valve closed	50	60	150
	Valve open	50	100	150
Pumps, reciprocating	By-passed	40	40	150
	Not by-passed	150	100	150
Rod mills-ore grinding	.....	175	110	175
Rolling mills, structural ,rail,				
Sheet plate and merchant	.....	40-60	30-40	250-300
Rod mills	.....	100	60	250
Hot strip mill	.....	50	40	250
Tube piercing, rolling and reeling	.....	60	40	250-300
Cold rolled sheet	.....	200	150	250
Brass and copper roughing	.....	50	40	250
Brass and copper finishing	.....	150	125	250
Rubber mills	.....	125	100	250

Typical values from this list of interest to steel people are given in Table III:

These requirements are not mandatory, however, and may be higher or lower as required. The point to be made here is that there is a wide divergence as to what torques a motor may have or be required to have. If a general purpose motor is ordered, it will have the torques listed. If your load requires something else, it is well to specify exactly what is needed or depend on the ability of the motor manufacturer to interpret your requirements. These standards represent good practice for the majority of cases, but they should not be regarded as the best the motor designer can do or the best for your particular application. As can be noted from these tables, the torques are greater for 0.8 pf than unity pf motors. The 0.8 pf machine is basically a larger machine and in addition to the corrective kva capacity it does have the additional torque. There are many cases when the proper consideration of motor torques in relation to power factor is not made.

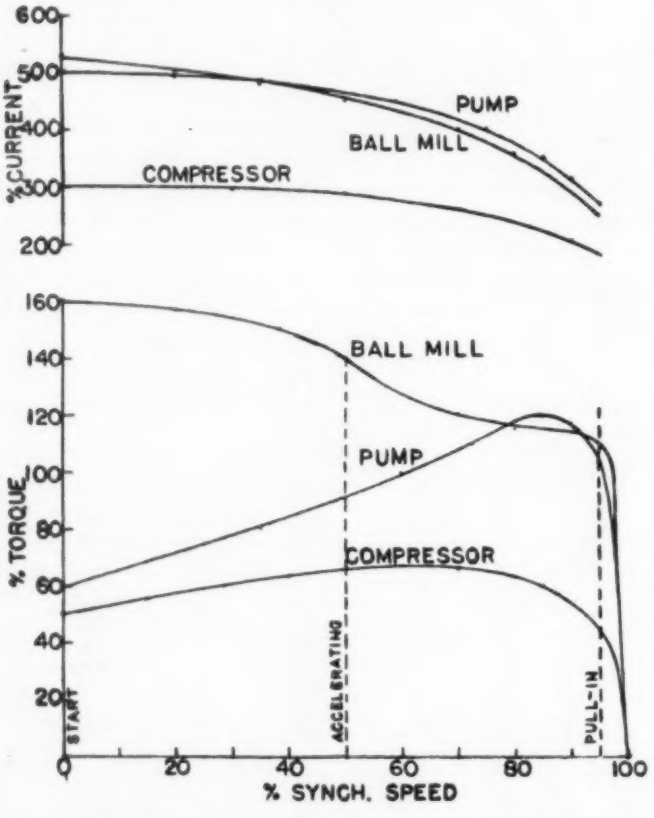


Figure 4 — Motor torque requirements of synchronous motors are given by these curves.

Where high starting, high pull-in and high pull-out torques are governing requirements of the drive, the leading pf motor is best adapted. Where leading kva is required for pf correction, its higher torques are available. Where the load fluctuates widely and rapidly, it also should be used because of its intrinsic higher pull-out characteristic. If high starting and pull-in torques only, and not high pull-out nor power factor correction, are the governing requirement, an oversize unity pf motor rather than leading pf motor may provide the most economical design.

In a synchronous motor the starting and pull-in torques vary as the square of the voltage applied, while the pull-out torque varies directly as the voltage. In an induction machine all torques vary as the voltage square. Thus, on fluctuating loads having high peak torque requirements, a 10 per cent voltage drop would leave 90 per cent pull-out available in a synchronous unit and only 80 per cent on the induction unit. This points up the advantage of synchronous motors on fluctuating loads and varying line voltage.

The approximate torque curves of three general types of loads are shown in Figure 4 for compressors, centrifugal pumps and ball mills.

The compressor, which is generally a low speed drive, has low starting and pull-in with a very low current inrush. The pump motor has moderate starting with increasing torque on acceleration to a high pull-in value. The ball-mill has very high starting torques with no more current than the pump and a reasonably high value of torque at pull-in.

As will be noted in the tables, an arbitrary division has been established in speed 514 and above as high speed, 450 and below as low speed. The torque specifications for these two divisions differ radically. In designing motors it is not possible to achieve this sharp change, but rather a gradual shift is made so that at certain ratings greater torque is available. Since the actual torques developed for each square inch of air gap varies over narrow limits, the torques are in reality determined in absolute value by the air gap area. In motor design this means that the strength of any machine depends on

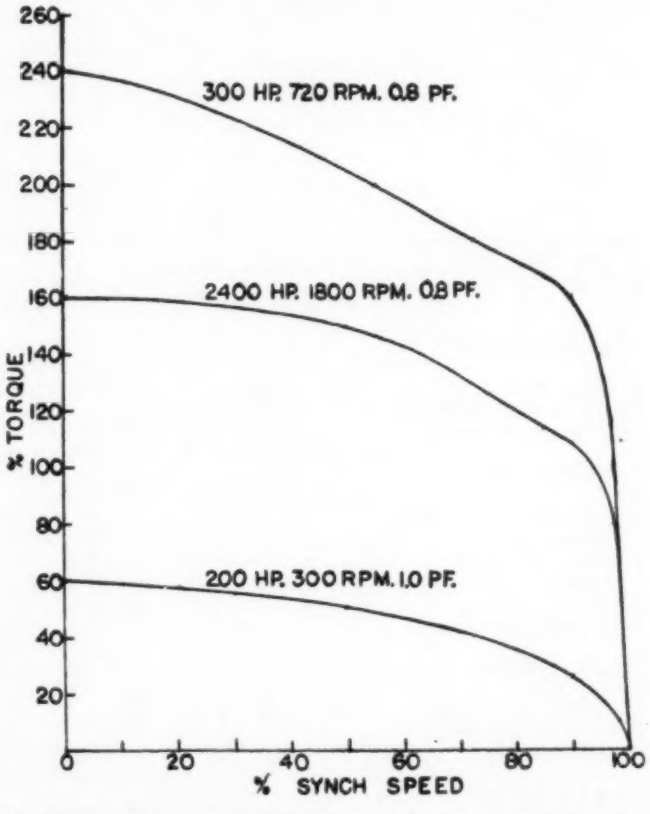


Figure 5 — Torques for brass bar cage motors are given by these curves.

its physical size in relation to the hp ratings. However, within certain limits each of the torques can be individually controlled, making it possible to tailor the design to the load requirements.

Pull-out torque is the value of maximum torque of synchronous speed operation at normal voltage and ex-

citation. Its value depends on the amount of air gap in the machine, increasing with increased air gap. It can also be increased by greater excitation, but at the penalty of higher armature current and lower power factor. The pull-out is a function of the short circuit ratio which is the ratio of field current for rated open circuit armature voltage to that for rated armature current on short circuit, or would represent the ratio of short circuit to normal current. A unity power factor motor will have pull-out of 140 per cent if scr is 1.0 and 160 per cent if scr is 1.2. An 0.8 power factor motor will have pull-out of 220 per cent if scr is 0.2 and 270 per cent if scr is 1.20. The result of a larger gap is felt directly in increased field winding which involves either a space or temperature limitation. Customers often question motor manufacturers about large air gaps in synchronous motors, while in reality they mean higher pull-out torque. In an induction motor a large air gap is a bad thing resulting is poor pf and low efficiency.

The starting and pull-in torques can be adjusted individually with the squirrel cage winding design and the field discharge resistor. In general, this follows the similar results in induction motors.

Where high starting torque with a lower pull-in torque is desired, a single cage high resistance winding would be used. Curves in Figure 5 illustrate typical starting characteristics of such designs. In this type a brass squirrel cage in circular slots at the pole surface is used. Higher resistance alloy bars are sometimes used where more starting is needed.

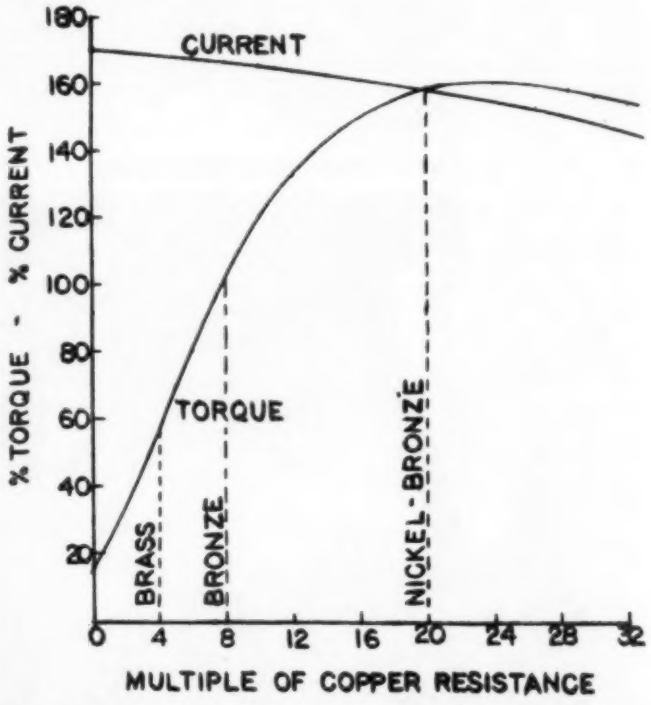


Figure 6 — Curves give effect of bar resistance on starting torque.

Applications for this requirement are attrition mills, ball mills, mixers, crusher, loaded pumps and rod mills. They may be either high or low speed. Figure 6 shows how starting torques can be increased by increased rotor resistance with little change in inrush current.

Where starting requirements are low and pull-in torque high, a high reactance low resistance cage, together with a low reactance stator are used. Curves in Figure 7 illustrate typical characteristics. This squirrel-cage winding is copper, circular or square section and near top of poles. The low resistance cage reduces the slip near pull-in to a low value and makes synchronizing easier. Typical applications include pumps, blowers, fans, compressors and motor-generator sets. Some compressors and motor-generator sets require approximately flat curves and can be obtained with this design or with brass bars, either way. The starting requirements are low enough to be achieved almost any way.

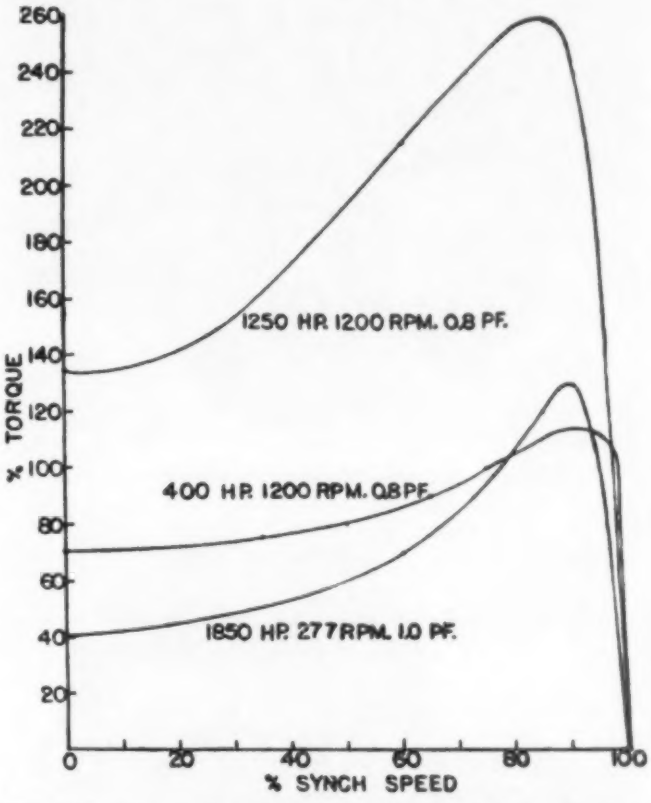


Figure 7 — Curve shows torques for copper bar cage motor.

Figures 8-13 show typical high and low speed rotors of this construction.

On such drives as rubber mills, ball or tube mills, brass and copper finishing mills, flour mills and other high inertia loads, both starting and pull-in torques are required. Sometimes, in addition, severe current inrush restrictions are made. In such cases it is necessary to utilize a double cage winding with copper bottom bars and brass top bars. This results in a high sustained torque through the acceleration period with high torque efficiency (high increment of torque per increment of kva). Illustrative of the torques of this design is Figure 14. Figure 15 shows the rotor construction. This construction may be necessary even in motor-generator sets if the inrush currents are to be held very low.

High speed synchronous motors frequently have more than enough torque to meet the starting and pull-in requirements for a specific application. It is sometimes desirable to reduce these values to reduce starting current. Systems of small capacity often require a limit to starting currents. The use of single or double cage, special form, and slotting of field poles, and the use of various alloy cage bars permit a wide variation in re-

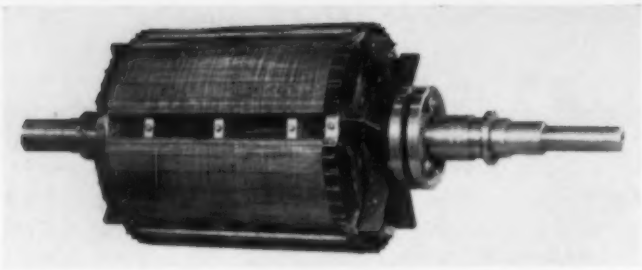


Figure 8 — Rotor for high speed synchronous motor.

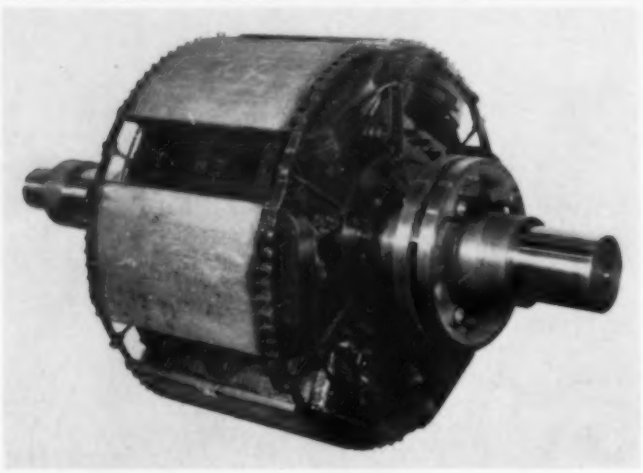


Figure 9 — Another high speed rotor design.

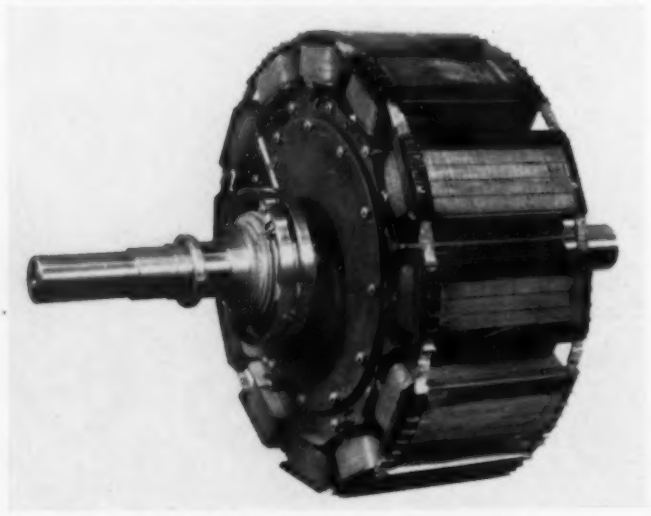
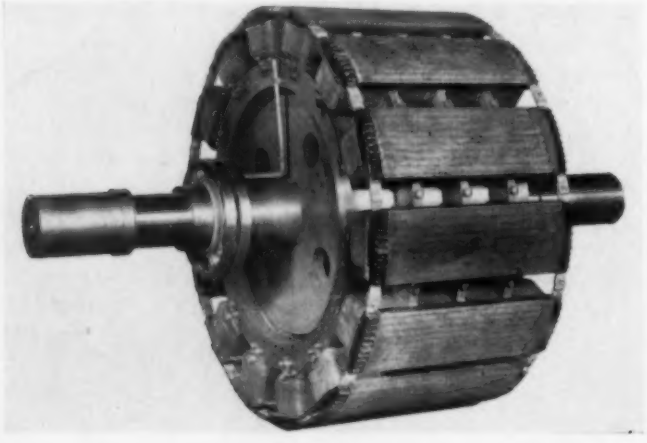


Figure 10 — A medium speed rotor design.

Figure 11 — Another medium speed rotor design.



sistance and reactance of the squirrel-cage starting winding. This, in combination with variation of the stator reactance, is used to get the best starting performance. In this way the design is not unlike the variations which are used in induction motors to produce across-the-line starting with minimum current inrush and high starting torque.

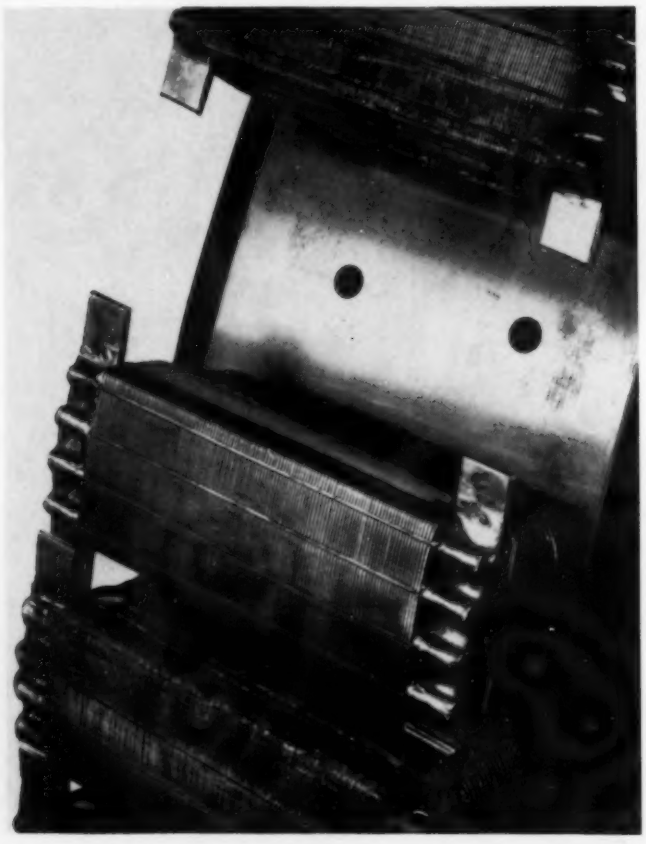
On synchronous motor-generator sets, for example, the torque requirements may be only 40 per cent starting and pull-in. Such torques generally can be obtained with 400 per cent inrush, whereas standard torques of 110 per cent would require 500 per cent or more. Table IV gives approximate full voltage starting kva of unity pf synchronous motors. For 80 per cent power factor motors these values will be 80-85 per cent of these.

TABLE IV

Per Cent Torque			Per Cent Starting Kva
Starting	Pull-in	Pull-out	
50	50	150-175	375-400
50	75	150-175	400
75	75	150-175	400
75	110	150-175	500
110	110	150-175	500
125	110	200-250	550-600
150	110	150-175	550
175	110	200-250	600-650

There may be other applications of high speed units which definitely require low instead of high torque. Such units have been built for air conditioning drives at 1200 rpm, where the motor must start slowly to permit proper

Figure 12 — Detail of low speed rotor design.



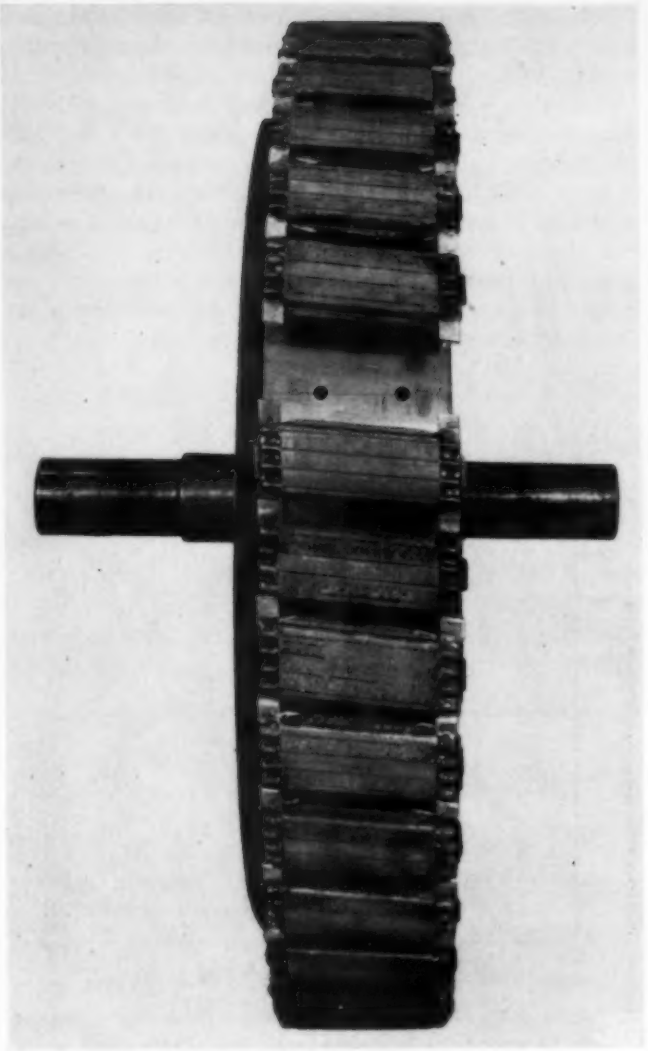
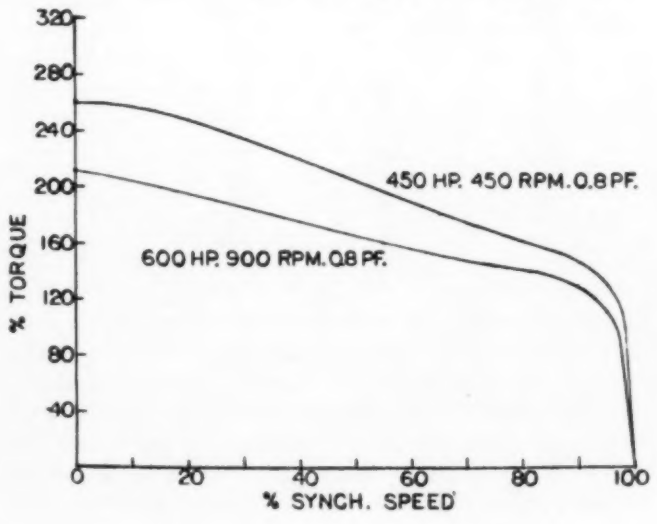


Figure 13 — Overall view of low speed rotor design.

lubrication. This drive requires very low starting torques 30 per cent less than 50 per cent pull-in, no torque point less than 30 per cent and a long overall starting time. The curve of such a motor is shown in Figure 16. It is obtained with a minimum of copper squirrel cage and in

Figure 14 — Torques shown are for double cage brass-copper rotor in high torque synchronous motors.



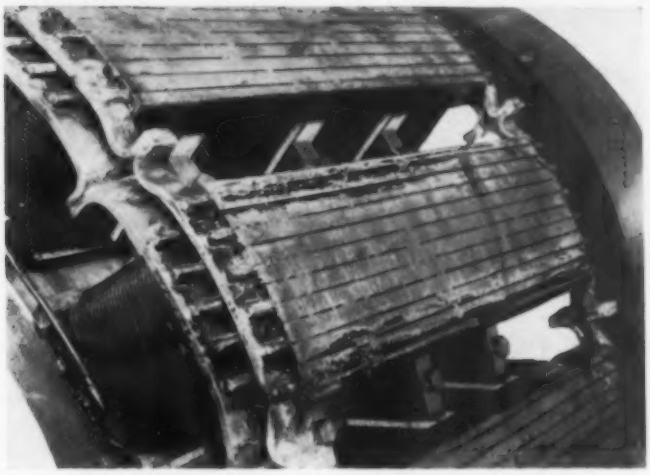


Figure 15 — Illustration shows details of double cage rotor.

certain cases a partial cage may be used. Figure 17 illustrates this construction. These motors had to be strong enough for normal pull-out and 0.8 pf. It is hard to take torque out of a high speed motor designed for 0.8 pf, for 200 per cent pull-out which will give not more than 30 per cent start and 50 per cent pull-in.

In high speed motor ratings the problem of selection between a synchronous type and an induction type may

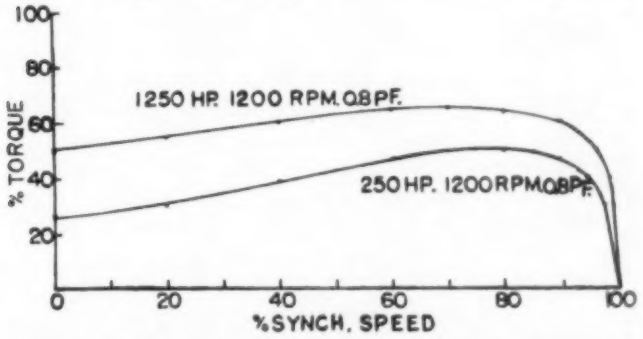


Figure 16 — Curve gives torque for low torque, high speed, synchronous motor with partial copper gage.

not always be clearcut. Engineers may differ in some cases as to what type to install. Considering the cost of control and excitation, any horsepower rating greater than its speed can be installed cheaper in a synchronous motor.

Figure 17 — Details of low torque rotor are shown in this illustration.

For driven machines at constant low speed there is less possibility of a difference of opinion. For a drive at 450 rpm or less a synchronous motor is almost always selected even where the hp is as low as 100 hp.

Standard torques used by the industry for low speed synchronous motors are 40 per cent starting and 30 per cent pull-in with a pull-out of 150 per cent for 1.0 and 200 per cent pull-out for 0.8 pf. These torques are only one-third of that required for high speed motors. For these low speed applications, generally the copper type bars will give enough torque. In some cases it is just as cheap to use brass bars which will insure sufficient starting torque without letting pull-in get below normal.

The normal starting and pull-in torque available from the synchronous motor depends on the horsepower, the speed and also the pull-out torque. Some indication of how the torques vary is shown in the empirical curves of Figure 18.

Thus it is seen that the starting torque characteristics depend to a large extent on the speed rating of the motor. The slow speed motor has high impedance because of its large magnetic structure per horsepower, hence it has low in-rush 300-400 per cent giving low normal starting and pull-in torque. Above 450 rpm, the motor has a

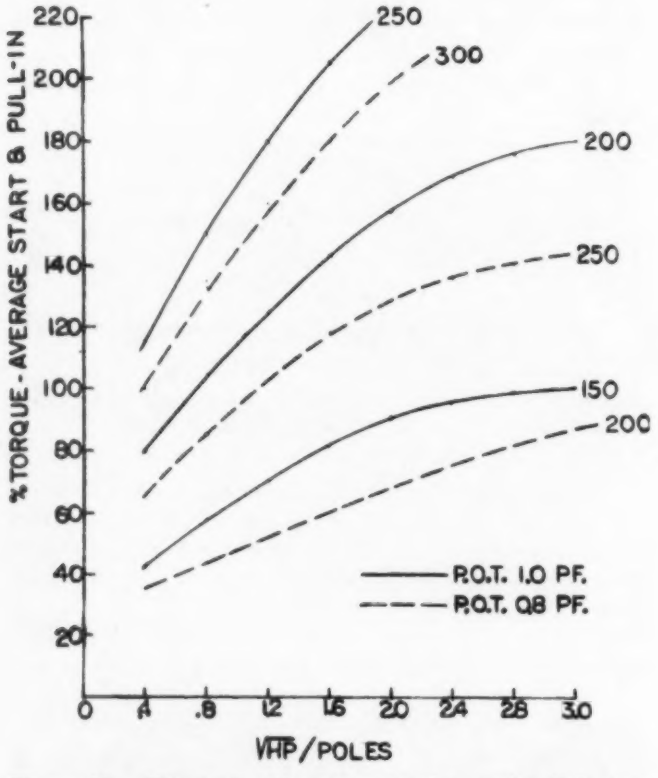


Figure 18 — Effect of pull-out on starting and pull-in torque is shown on these curves.

smaller magnetic structure per horsepower, has lower impedance, giving higher inrush 500-600 per cent and thus high normal starting characteristics.

There are many slow speed applications, such as unloaded compressors and motor-generator sets, where the standard torque requirements will meet the requirements. There are others which require considerably higher starting and pull-in. These include ball and tube mills for grinding rock porducts and ore, banbury mixers and mill lines, rubber mills chippers.

The two general divisions are illustrated in Figure 4 and the discussion above indicates the design variations to suit.

An often misunderstood element in connection with synchronous motor torque is the effect of the field discharge resistance. A resistance is connected across the synchronous motor field to limit the induced voltage when the d-c excitation is removed. The same resistor may be used to limit the induced voltage on starting, providing it is the proper value. This resistance when connected across the field does have an effect on the starting and the pull-in torque. In fact, the determination of

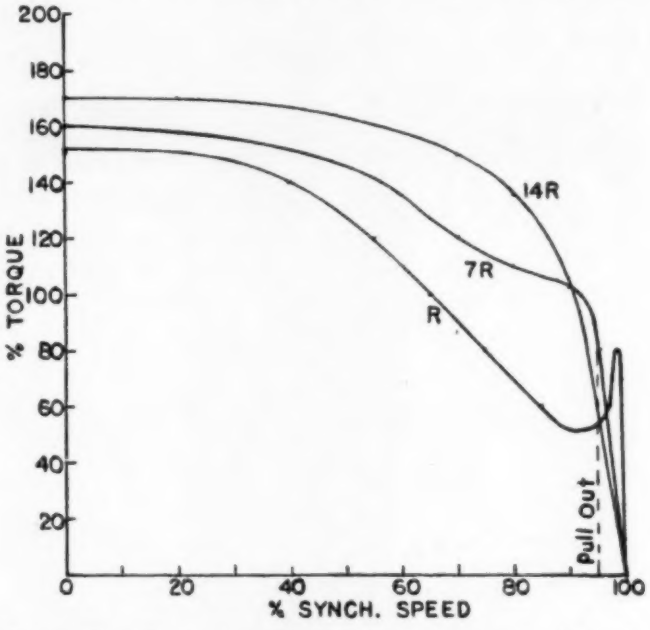


Figure 19 — Curve shows effect of field discharge resistance on synchronous motor torques.

ohmic size is dependent almost wholly on the proper value to give maximum pull-in torque. In Figure 19 the curves show this effect.

In Table V the effects of change in external field resistance can be observed for a sample synchronous motor.

TABLE V

Discharge Resistance	Starting Torque	Pull-in Torque	Current Inrush
0 –	0.87	0.88	6.0
1 Rf	0.88	1.18	6.0
2 Rf	0.89	1.36	6.0
4 Rf	0.90	1.52	6.0
5 Rf	0.92	1.71	6.0
6 Rf	0.91	1.52	6.0
8 Rf	0.91	1.46	6.0
10 Rf	0.92	1.42	6.0
12 Rf	0.93	1.37	6.0
25 Rf	1.00	1.19	6.0
100 Rf	1.10	1.14	6.0
Open field	1.11	0.82	6.0

In cases involving low starting torque and high pull-in, such as the pump or fan characteristic, the discharge resistor value is very important. It has been general practice to use a valve 5-7 times the field resistance, but in specific cases the proper value may result in higher pull-in torque.

In summary, then, we find that two groups have standardized torque values for typical synchronous motor ratings. These are NEMA and the AIEE. These standards apply to starting, pull-in and pull-out values and not to complete speed torque curves. In actual practice, application requirements may depart considerably from these standardized values.

Motor designers have numerous means at their disposal, such as motor strength, bar design and material and discharge resistor, to adjust the motor torques to the application needs. For unusual or severe applications, the user should be rather specific as to his needs and take the motor application engineer into his confidence. In this way, the motor can be tailored to the job and the result will be the best motor for the application.

If the torques are achieved in a synchronous motor, then its other advantages of efficiency and power factor will combine to make its application of real benefit. There may be a slight penalty in cost, but the advantages more than make up for this. Their user will get a motor just as dependable as the well-known rugged induction motor.

DISCUSSION

PRESENTED BY

H. S. MAXWELL, Steel Mill Application Engineer, General Electric Co., Schenectady, N. Y.

R. E. EDWARDS, Elliott Co., Ridgeway, Pa.

R. H. WRIGHT, Steel Mill Engineer, Westinghouse Electric Corp., East Pittsburgh, Pa.

H. H. ANGEL, Electrical Engineer, Bethlehem Steel Co., Behtlehem, Pa.

DR. W. A. THOMAS, Chief Engineer, The Electric Products Co., Cleveland, Ohio.

H. S. Maxwell: This has been a most interesting discussion of basic considerations relating to synchronous motor design torques and various load requirements. As this discussion leads into the subject of application, for information relating primarily to application of synchronous motors we suggest reference to "Applying Synchronous Motors To Main Roll Drives" by Mr. L. A. Umansky, AISE Proceedings, 1935-36, pages 299-315. This has been a primary reference of our application engineers since publication.

Applications, in order of interest to those in the metal rolling industry are probably applications to:

1. Large motor-generator sets.
2. Rod, bar and tube mills.
3. Air compressors.
4. Water pumps.
5. Sintering fans.

The first four are moderately low inertia loads, but sintering fans may be as high as sixty times normal WK^2.

We believe Dr. Thomas has indicated incorrectly that tables I and II, which are identical, refer to nominal pull-in torque at 95 per cent speed. Values given are for pull-in torque based on normal WK^2, a value of load inertia calculated by formula, standardized by NEMA about 1936 in order to have a basis for standardization of the minimum values of pull-in torque for the various lines of synchronous motors. Table III, however, which shows expected requirements of various loads, gives pull-in torque values based on actual expected inertias.

Users will find torque requirements of various machinery used in rolling mills well established in most cases, because of repetitive manufacture. In the field of ore preparation, however, the increasing use of lower grade ore will bring about increasing orders for synchronous motors for ore preparation mills of various types such as ball mills, rod mills and tube mills. Torque requirements for such applications are frequently indefinite. In this regard, Mr. Thomas' mention of rod mills requiring high starting torque should not be confused with rod rolling mills, which do not require high starting torque.

Mention is made of various air gap considerations including short circuit ratio. We consider these to be of design interest only. Brief mention is made of torque efficiency. We consider this a basic conception, very useful when considering the application of synchronous motors.

Fluctuating loads have been associated with the possible need for high pull-out torque. Added flywheel effect is often a better solution in reciprocating compressor applications.

Dr. Thomas mentions in summary that applications may depart considerably from standardized torque values. It may be of interest to note that departures for high speed motors usually are required by inrush current considerations, and departures for low speed motors by departures from compressor applications. The division between high and low speed at 450 rpm exists because most synchronous motors 450 rpm and below have been applied to reciprocating compressors and designed to meet their torque requirements. Such motors are usually supplied to the compressor manufacturer, stator and rotor only, without shaft and bearings.

Dr. Thomas has stated that synchronous motors challenge induction motors for all applications except in small sizes. We agree that synchronous motors should receive serious consideration, but there are many applications where induction motors will be indicated. Considering the high reliability of synchronous motors and control of present design, however, it is no longer necessary to weigh reliability in choosing between induction and synchronous motor drive.

R. F. Edwards: Dr. Thomas has presented a paper aimed at drawing the attention of the users of electric motors to the point in synchronous motor application which is generally least understood, that is, torques. In one of the few cases today in which a synchronous motor fails to perform as required, that failure almost invariably stems from a misunderstanding of the torque requirements or inertia of its load.

I would like to comment on some of the points brought out in the paper, and to add a point regarding transient torques which I believe is of general interest.

It is important that we distinguish the difference between *nominal* pull-in torque discussed in the paper and pull-in torque (sometimes emphasized by calling it *actual* pull-in torque), which by ASA definition is the actual maximum constant torque under which the motor will pull its connected load into synchronism when its

field excitation is applied. The statement by Dr. Thomas that "there may be applications where adequate pull-in torque is available but the motor will not synchronize" is not consistent with the foregoing definition. It has been our practice to check the actual pull-in torque of every synchronous motor as a routine step in its design, and to provide an adequate value.

A term defined by ASA but not included in the paper is pull-up torque, which is in effect the minimum torque developed by the motor at any speed from standstill to the point of pull-in.

In order for the motor designer to provide a machine having the proper starting, pull-up, and pull-in torques, it is necessary that he be provided only with the steady state speed-torque characteristic, including break-away torque, of the driven equipment, and its inertia. Evaluation of effective inertia is difficult for some applications, such as large water pumps and ship propellers where entrained water adds inertia and damping, but very few if any drives in steel mills involve such a problem.

Normally the user need not concern himself with the value of accelerating torque, since it affects only the time required by the motor to start and accelerate to the pull-in point. It is only in special cases that this starting time is of major consequence, and in those cases it is usually a problem raised by the manufacturer of the driven equipment. Irregularities or cusps in the speed-torque characteristic of the motor are problems to be considered and solved by the designer.

Pull-out torque is usually thought of in terms of the maximum steady state torque a synchronous motor will deliver. However, the same machine will handle considerably higher suddenly-applied, short duration, peak loads. This higher torque capability is known as transient pull-out torque. This property of a synchronous motor is utilized for a number of rolling mill drives arranged for field forcing or regulated for constant power factor or constant reactive kva operation. The transient torque capacity holds the motor in synchronism when the load is suddenly applied, while the excitation is being built up at a necessarily slower rate. In connection with this transient torque, it is well to mention that in some rolling operation, rather high transient torque requirements are encountered, frequently, but not with predictable regularity, due to slippage and siezing of the steel in the mill. Two machines having the same steady state pull-out torque but different transient reactances could give completely different performance under these conditions.

The effect of the inertia of a load on torque requirements and on the machine design is frequently misunderstood. Aside from its effect on pull-in torque, mentioned in the paper, it affects only the size and configuration of the amortisseur winding, which must be large enough to safely absorb the heat generated in it during each starting cycle. Inertia affects the time required to accelerate from standstill to the pull-in point, but has no effect whatsoever on the torque required by the load. Dr. Thomas has defined accelerating torque as that portion of the motor developed torque which is available over and above the load torque to produce acceleration of the system inertia.

The paper does not mention the high torque it is possible to attain for emergency stopping of synchronous motors by dynamic braking; they can be arranged to provide a quicker stop than induction motors or direct-current motors.

The general relationships between rated machine power factor and torques do not alone dictate the most economical power factor rating for an installation. Since practically identical torque and current characteristics can be built into either a unity power factor or an 80 per cent power factor motor, the cost of each rating must be weighed in relation to the effect of reactive kva on power costs in each installation.

R. H. Wright: While Mr. Thomas has not discussed any specific rolling mill applications he has given an excellent general outline of the characteristics which can be provided by a synchronous motor.

Mr. Thomas has mentioned the tendency to use 80 per cent power factor motors for applications which require high torques. In these days when power factor correction is not always a prime requirement, it should be kept in mind that suitable torque characteristics can also be obtained with motors designed for 100 per cent power factor. With the same frame size the same torques can be had at either 80 or 100 per cent power factor.

Many steel mill engineers wil remember that when the synchronous motor first came into use for rolling mill drives, the principal application was for driving continuous bar, billet and rod mills. The horsepower ratings were large, and the speeds were low so as to provide a direct drive of the mill lay shaft. The only available alternative was the slow speed wound rotor induction motor which had a poor power factor, particularly on 60 cycles.

At this time, power systems were limited in capacity and starting was the chief problem. Numerous schemes were used to reduce the starting current. To mention a few, there was the two-step closed transition autotransformer or Komdorfer system, the part winding method, the revolving stator, the clutch type motor and the simplex motor which was started in somewhat the same manner as a wound rotor motor. All these complicated devices were merely expedients to provide starting characteristics which are not inherent in a synchronous motor. With the present large power systems, starting is not a major problem. By utilizing some of the design features described by Mr. Thomas, the desired starting characteristics can be obtained without sacrificing any of the inherent simplicity of the synchronous motor.

Present practice in the selection of a-c motors for use in steel plants is about as follows:

1. Use squirrel cage motors wherever possible in order to obtain the most simple motor and control. The inherent characteristics of the squirrel cage motor limit its use to a few specialized mill drives requiring less than 1000 horsepower and to drives for exciters and constant speed auxiliaries.
2. Use synchronous motors for larger capacity constant speed drives for which the proper torque characteristics can be obtained without resorting to extremely complicated design. Start at full-voltage or with a reactor. In other words, make the installation as simple as possible.
3. Use wound rotor motor for special applications.

H. H. Angel: Dr. Thomas has presented a very fine paper on the above subject, giving us some interesting tables and charts on motor torque requirements for various applications, effect of discharge resistance, effect

of rotor bar resistances, etc. I believe I can hazard a guess that many of us in the audience have not realized the influence of the above on motors now in operation. I have the following questions to ask Dr. Thomas:

1. It is often difficult to decide whether an induction motor or a synchronous motor should be installed. I would like to get more details about the statement "that considering the cost of control and excitation, any horsepower rating greater than its speed can be installed cheaper in a synchronous motor."
2. Has the author had many cases where, in attempting to get high starting and pull-in torques only, oversize unity pf motors were applied rather than leading pf motors.
3. Table V shows the relation of discharge resistance to starting torque, and pull-in torque. Increasing this resistance above 5 to 7 times the field resistance will increase the starting torque 10 per cent. What is the danger of the starting induced voltage on the rings damaging the insulation?

W. A. Thomas: In answer to Mr. Maxwells' questions on Tables I and II, I believe the paper adequately distinguishes between nominal pull-in and actual pull-in. Having attended a good many NEMA sessions, it is sometimes very difficult to know exactly what they are defining in their standards. Mr. Maxwell has given a historical reason for the selection of 450 rpm as the breaking point between high and low speed. However, present day applications cross over both ways placing some questions on this point.

In Mr. Maxwells closing paragraph, he questions the advisability of using synchronous motors although admitting that the reliability is now the same for both. This is an important point. For if reliability is the same, only cost must be evaluated, including the advantages of power factor and efficiency in the synchronous motor.

Mr. Wright points out the importance of motor selection and gives us a valuable guide for selection.

Mr. Edwards emphasizes the necessity of checking the actual pull-in torque as a routine design step. We do this on every one of our designs and make a further check on test when possible. The point I was making was that often synchronous motors fail to synchronize not because of design omission but rather the customer has specified incorrectly his load requirements. Mr. Edwards further describes transient torques which are a valuable additional consideration.

Mr. Angel has asked three rather specific questions.

1. The statement "That considering the cost of control and excitation, any horsepower rating greater than its speed can be installed cheaper in a synchronous motor", should not be extended too far as it is a general idea. It is better to evaluate each application in itself based on present costs both for material and labor and also evaluating over a period the benefits of higher efficiency and power factor. Although seeming to be more expensive, the synchronous motor may in the long run be cheaper.
2. We have had a few cases where a unity power factor motor could be installed to get high starting and pull-in torque. There should be many cases like this as Mr. Wright has pointed out. The subject is often misunderstood by sales departments who overlook possible cases.
3. The figure of 5 to 7 times the field resistance for the discharge resistance is a safe one. There certainly is danger of increasing it too high with consequent over-voltage on the rings. I would say 10 to 15 times would generally be safe. A protective gap on the rings can be used as a safety factor.

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By S. RIFKIN, Industrial Engineering Department, General Electric Co., Schenectady, N. Y.

TRENDS IN ELECTRICAL EQUIPMENT FOR MATERIALS HANDLING IN THE STEEL INDUSTRY

. . . . the trend in steel plant materials equipment is toward larger, safer and more precisely controlled units . . . .

▲AT the outset, it must be emphasized that this paper will be concerned only with trends in electric equipment. No attempt will be made to discuss the merits of one type of materials handling machine or system as compared to another, since a subject of that scope could be adequately covered only by one or more volumes. In the 1950 edition of the AISE Yearly Proceedings alone, there were 18 articles covering 111 pages dealing with some of the many aspects of materials handling. In one plant, 20 to 25 per cent of the total production labor cost was required for handling materials.[1*] Another article states, "In the average steel plant about 40 per cent of all labor on the payroll is involved directly or indirectly in the handling of materials."[2] Either basis represents a tremendous expense and justifies serious consideration of every possible means to obtain improved performance or increased safety from materials handling machinery.

TRUCKS

Almost every size and type of electrically-powered truck can now be found at work some place in a steel mill. The truck may be equipped with forks, a platform, a scoop, a ram, a crane, or be used as a tractor for hauling trailers. The operator may walk, ride in a standing position, or be seated. The motor may be controlled by a drum switch or a magnetic control panel. Whatever the application, if the lifting distance is not excessive, if the load is not too heavy and does not have to be carried overhead, a suitable electrically-powered truck can probably be found. As an example of the large trucks that can be obtained, Figure 1 shows two 40-ton ram trucks, on which the diesel-generator of a 25-ton locomotive was used to supply power to the various motors.

*Numbers refer to Bibliography at end of this article.

CONVEYORS

When there is a repetitive flow of material between definite points, whether it be continuous or for a relatively short time interval, a conveyor will normally receive primary consideration. A typical example would be a belt conveyor for supplying coke directly from the coke plant to the blast furnace storage bins. Another example would be a chain, pallet, or car type coil conveyor. The large majority of conveyors are driven by squirrel cage motors with simple across-the-line starters. When the maximum permissible pull in the belt during acceleration is less than the pull corresponding to the maximum torque of the motor, reduced-voltage starters are required. If the conveyor belt is long and the load heavy, the belt may be quite an expensive item. In order to avoid stretching the belt, it may be necessary to utilize an acceleration time that is longer than the rotor of a squirrel cage motor can withstand.

Figure 1 — These 40-ton ram trucks, used in steel mill coil handling service, are powered by the same diesel generator as a 25-ton locomotive.

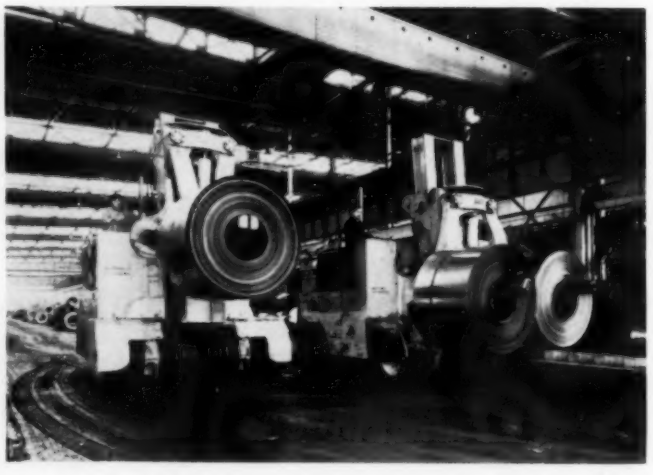


Figure 2 — Conveyors are extensively used in the stocking of raw materials in a steel plant. Installation here shown is the Corporacion de Fomento de la Produccion in San Vicente, Chile. This equipment is powered by 380-volt, 60-cycle, 3-phase motors.

In that event, a wound rotor motor may be applied with a special control panel and resistor having more accelerating steps than required by NEMA standards. When a single conveyor is involved, the speed can be adjusted by means of resistance in the rotor circuit. However, the speed of a wound rotor motor with added rotor resistance will decrease as the load is increased; therefore, in a system where material is transferred from one conveyor to another, this type of speed control would not be advisable. Normally, the amount of material carried would be varied by controlling the openings of the gates feeding the first belt instead of by running the conveyors at less than rated speed. Of course, there are some installations where speed control is advantageous, and where adjustable-voltage drives will be justifiable.

Figure 3 — Controls are conveniently grouped in motor control centers. This unit is about 100 in. long, 90 in. high, and 20 in. deep.

The San Vicente steel mill raw materials handling facilities in Chile illustrate the use of squirrel cage motors with across-the-line starters on the relatively small conveyors, and with a reduced-voltage starter on the largest conveyor. A part of that installation is shown in Figure 2. The traveling stockpile tripper at the left of center in the photograph receives raw material from a system of conveyors and deposits it evenly in a pile on the selected side of the tripper. When the material is required, the reclaiming machine in the center scoops it into a trench conveyor that starts it on the way to the required location.

Standard electric equipment was used throughout this installation for economy and to facilitate delivery. The controls were grouped in appropriate motor control centers similar to the type shown in Figure 3, with the necessary interlocking features specified. Instead of ordering a special control desk, ten push button and indicating light assemblies of the type shown in Figure 4 were installed in the dispatcher's office.

Figure 4 — Push button and indicating light control stations give convenient operation.

The Iron Mines Co. of Venezuela (subsidiary of Bethlehem Steel Co.) installations at Palua for loading barges and at Puerto de Hierro for transferring ore to ocean-going vessels involved longer and higher-capacity conveyors. Wound rotor motors were used with 2300-volt magnetic starters having six accelerating steps designed to accelerate the high inertia of the loaded belt in approximately 25 seconds without excessive torque peaks.

For the utmost in versatility, U. S. Steel Co.'s Orinoco loading station in Venezuela will have rotating regulators controlled adjustable-voltage conveyor drives. Fast, but smooth, acceleration and deceleration will be provided by a current-limit circuit and the speeds of succeeding conveyors in the flow of ore will

be matched by the use of tachometer generators. This equipment is now being manufactured.

Of course, there are many more steel industry applications for conveyors besides the shipping and stocking of raw materials. Reasonably accurate selection of speed under a variety of loading conditions is required on a few of those applications, resulting in the use of adjustable-voltage drives. The package type assembly of motor-generator set, starter, and generator control panel is being well received on some of those installations.

CRANES

In May, 1949, after two years of development testing and six months of steel mill trial service, a new d-c crane hoist control circuit was introduced. Among the many desirable operating features provided by this new circuit are the following:

1. Heavier overloads can be lowered at full speed without overspeeding the motor.
2. Current, voltage, and torque peaks when stopping from full speed lowering are decreased.
3. A slower speed is provided for landing rated load on the first lowering point.
4. Jogging accuracy is improved in both the hoisting and lowering direction.
5. Rated load does not drift down on the first hoisting point.
6. An empty hook can be raised at a stable speed of less than 50 per cent on the first hoisting point.
7. The armature shunt connection on the first and second hoisting points provides dynamic braking to slow down an empty hook from a fast speed point.

When the new circuit was being developed, some other hoist circuits utilized a motor shunt connection on the first one or two hoisting points to provide slow speed control of an empty hook. As shown by Figure 5, if the overhoist power limit switch tripped while the motor shunt connection was established, the series brake would remain energized. The load would drop until the limit switch reset, at which time it would again be raised until the limit switch tripped. This

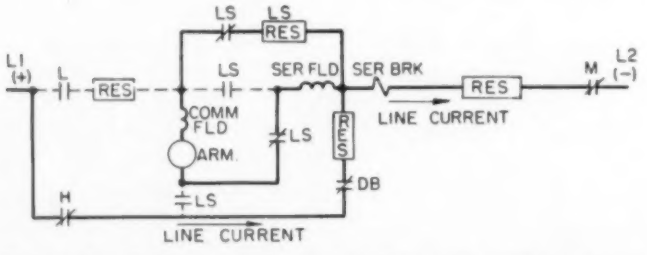


Figure 5 — Schematic shows hoisting with motor shunt connection and power limit switch tripped.

"cycling" operation would continue until the operator moved the master switch out of the motor shunt position. Even more serious was the possibility that an operator might move the master switch back into the motor shunt position when raising an empty hook at full speed. When the limit switch tripped under that condition, the dynamic braking provided by the current flowing through the limit switch resistor might not reduce the stored energy in the rotating system to a low enough value; therefore the impact between the hook block and the overhead sheave might result in snapping the cable and dropping the hook. In comparison, Figure 6 shows that the armature shunt on the first two hoisting points of the new circuit will provide a plugging connection when the power limit switch trips, and the plugging torque will stop a high speed empty hook just as rapidly as if the brake had set. Of course, the nuisance "cycling" operation would still be encountered; therefore relay LSHX was added as shown in Figure 6. The coil of that relay is connected across the motor series field when the limit switch is in the normal untripped position. When the limit switch trips, the coil is connected across the limit switch resistor, and the voltage resulting from the dynamic braking current flowing through that resistor will pick up the relay; thereby dropping out the L contactor to remove power from the motor and set the brake. Relay LSHX

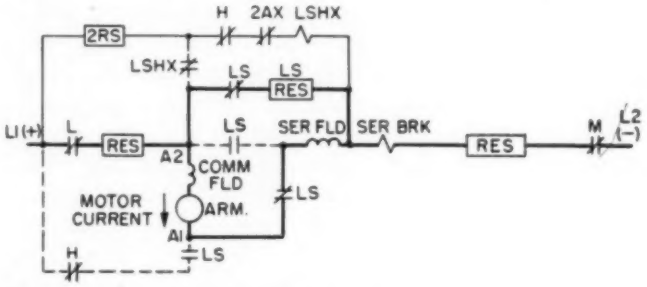


Figure 6 — Schematic shows hoisting on first or second point with power limit switch tripped.

remains picked-up through resistor 2RS until the master switch is moved back into the "Off" position.

One of the most serious failures that can occur on a crane operated from a d-c power supply is the failure of a power limit switch to reset when a load is being lowered out of the "limit switch zone." Figure 8 is typical of the connections that are established by standard crane hoist circuits when lowering with the limit switch tripped. The motor armature and field are connected directly in series, since the limit switch contacts must establish a circuit that will provide dynamic braking in the hoisting direction. With the lowering connections shown in Figure 7, the motor tends to drive in the lowering direction; thereby accelerating the inertia of the drive more rapidly than if the brake had simply been released. If the limit switch fails to reset, an unsafe speed is likely to be attained before the operator realizes that anything is wrong. By the time the operator moves the master switch handle back into the "Off" position, the stored energy in the load and the rotating parts may be so high that the brake will be unable to stop the load before an accident results.

Further circuit development led to the connection shown in Figure 7 for relay LSHX (the same device used to prevent "limit switch cycling" in the hoisting direction). The proper selection of resistor 3RS results in LSHX picking up if the limit switch fails to reset before the motor attains slightly more than rated speed during acceleration in the lowering direction. The relay remains picked-up until the master switch is recentered; however, without waiting for the defective

limit switch to be repaired, the load can be lowered to the desired position by a series of short operations, with relay LSHX limiting the motor speed to a safe value for each operation.

Another improvement in crane controls is a revised plugging circuit for bridge and trolley motions. Figure

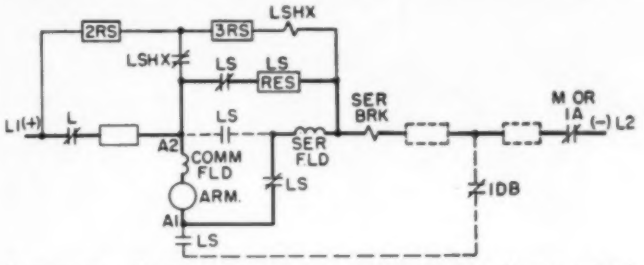
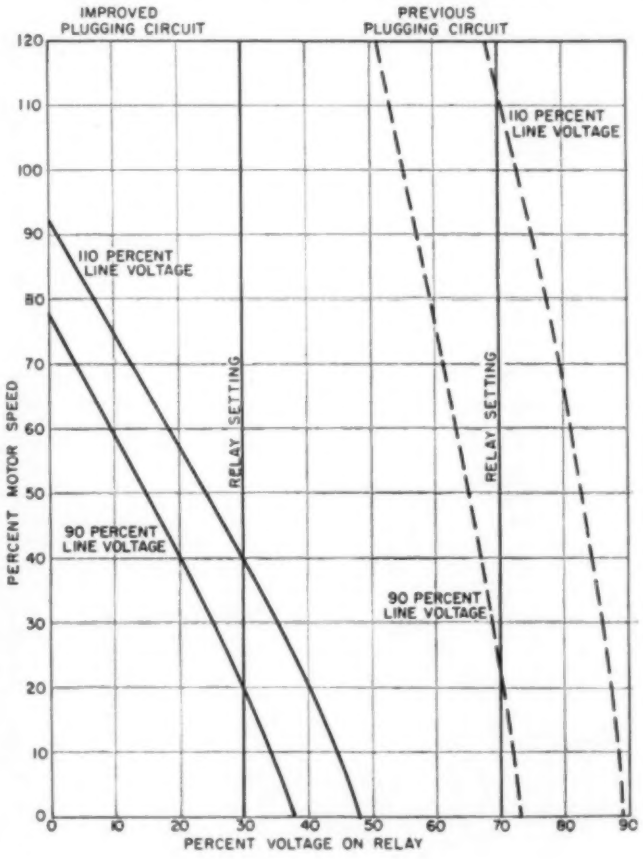


Figure 7 — Schematic shows lowering with limit switch tripped.

8 shows the effect of line voltage fluctuation on plugging performance with the revised circuit compared to the performance obtained with the previous plugging circuit. For example, if the relays are set to operate at 20 per cent motor speed when the line voltage is 90 per cent of rated voltage, an increase to 110 per cent voltage will result in operation at 40 per cent speed for the improved circuit compared to 112 per cent speed for the previous circuit.

The present day high efficiency of gears and antifriction bearings frequently results in a "free-running" torque that is a relatively small percentage of rated motor torque. Consequently, if the first master switch point provides sufficient torque to "break away" against static friction, the "free-running" speed of the series motor on that point may be relatively fast. If accurate bridge or trolley positioning is essential and if the crane is designed with a fast geared speed, it is advisable to include an armature shunt connection on the first one or two speed points in each direction. A soaking pit crane is a good example of an application where this feature is desirable to permit accurate positioning of an ingot without damaging the pit lining. Not only does the armature shunt connection permit creeping speed control, but it also enables the operator to decelerate gently from top speed, while at the same time retaining the option of a more rapid deceleration by means of plugging.

Figure 8 — Curves show improvement obtained in plugging performance between the old and new circuit designs.



COAL AND ORE BRIDGES AND UNLOADERS

Although adjustable-voltage drives have been used on coal unloaders at some public utility stations since 1923, the steel industry has only given serious consideration to that type of drive for bridges and unloaders during the past few years. In general, a-c power was utilized on rope-operated unloaders, and d-c constant-potential power on Huletts, man-trolley unloaders, and bridges. For example, the three Iron Mines Co. of Venezuela unloaders have 2300-volt, 60-cycle wound rotor motors on the main drives and the two ore bridges operate from a 230-volt d-c system. Since the plans for that installation were made before World War II, it is not difficult to understand why adjustable-voltage drives were not considered—at that time, even the mills in this country had very little experience with rotating regulator control.

During the past few years, there has been considerable interest in the use of adjustable-voltage on bridges and unloaders. Some installations are being made in locations where similar equipment is operated from a 230-volt d-c supply, but where it would have been necessary to increase the size of the power conversion substation if adjustable-voltage had not been selected for the new equipment. Other installations have been made in completely new locations, and the conversion substation has been eliminated. The a-c power supply to these adjustable-voltage bridges and unloaders has ranged from 550 to 4160 volts.

Figure 9 shows one of two duplicate rotating regulator controlled bridges at the Dominion Foundries & Steel Co. in Hamilton, Ontario. A similar, but higher capacity bridge is in service at the Steel Co. of Canada plant in Hamilton. A rope-operated rotating regulator controlled unloader is in service at the Weirton Steel Co., and a man-trolley type unloader is being installed at Mobile for the Tennessee Coal Iron & Railroad Co. Other rope-operated and man-trolley type unloaders have been and are being installed at power stations and railroad docks. Huletts with adjustable-voltage beam-hoist, trolley, and larry car drives have also been placed in service at railroad docks on the Great Lakes.

A few of the advantages of adjustable-voltage drives may be summarized as follows:

1. It is normally possible to use a smaller frame size motor for a given duty cycle, since 230-volt MD

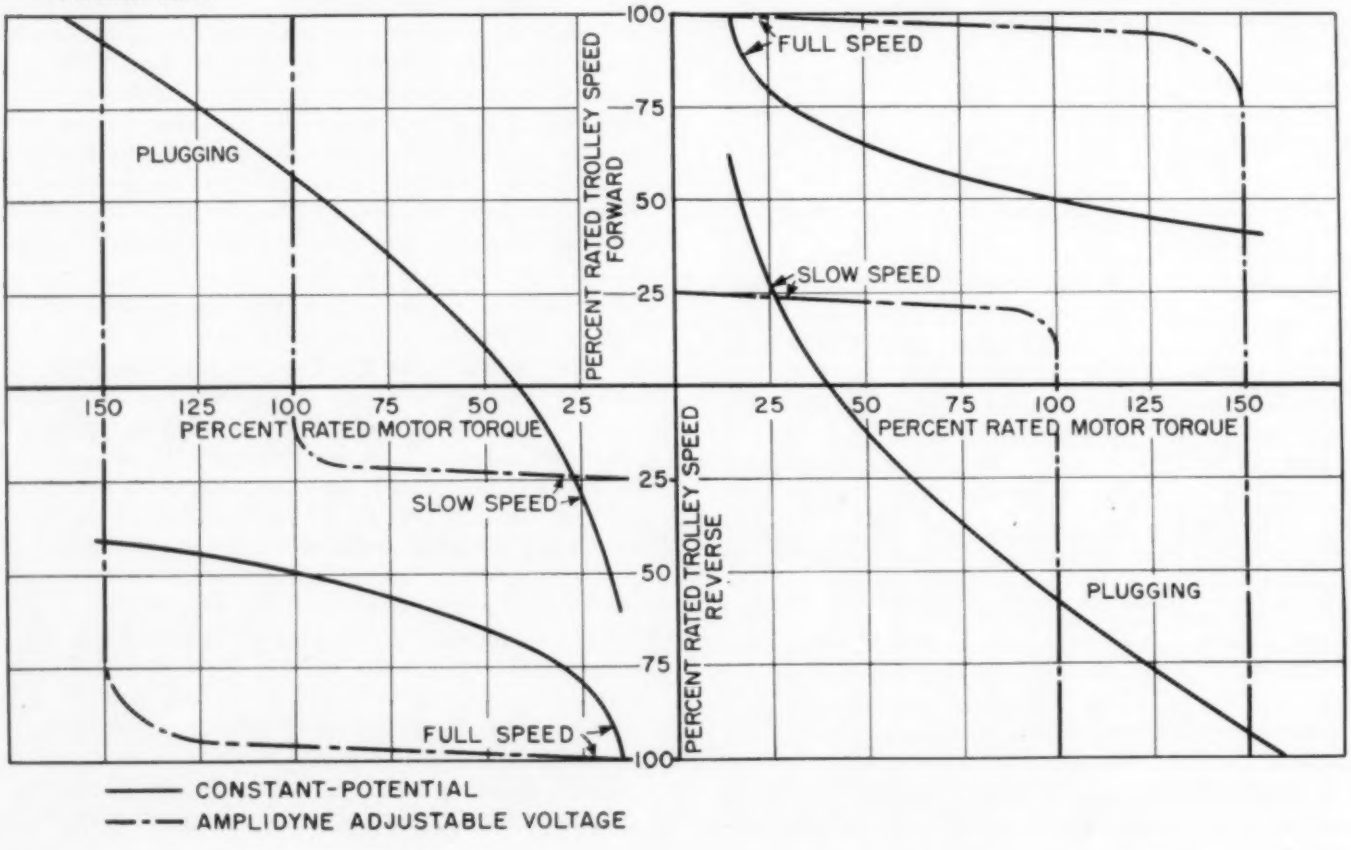
Figure 9 — This 12-ton ore bridge is located at the Dominion Foundries and Steel Co. Limited, Hamilton, Ontario, Canada.

and MDP motors can be operated at considerably more than rated armature voltage; thereby increasing the motor speed and the horsepower output.

2. The physical dimensions of a man-trolley can be decreased due to the smaller motors, the elimination of large banks of power resistors, and the elimination of all but a few large power contactors.
3. Rotating regulator controls can incorporate automatic features that make it possible to run the unloader or bridge with considerably less master switch manipulation, and therefore less operator fatigue. The hoisting load can be automatically divided between the holding and closing lines, and the lowering speeds of the two lines can be matched during acceleration and deceleration so that there will be no tendency for the bucket jaws to close as long as both master switches are moved simultaneously. If the operator wishes to open or close the jaws as the bucket is being lowered, he need only move one master switch ahead of the other to interrupt the speed matching circuit.
4. An adjustable-voltage trolley will cover the average distance in a shorter time than a constant-potential trolley. The dot-dash curves in Figure 10 show the slow speed and full speed characteristics of a rotating regulator controlled trolley compared to the solid line curves of a constant-potential trolley. Assuming that both types of drives are geared so that the same trolley speed will be attained within the average distance, the rotating regulator controlled installation will bring the trolley up to full speed in a shorter time and distance than the constant-potential drive. The two types of control could be adjusted to provide the same maximum rate of acceleration from standstill to approximately 50 per cent speed, but the decreasing torque of the series motor as speed increases would then result in slower acceleration than the relatively constant torque provided by rotating regulator control. On many constant-potential installations, the trolley never does attain nominal rated speed within the average travel distance.

The difference in plugging performance is also shown in Figure 10. If the trolley is running at full

Figure 10 — Curves show comparison of rotating-regulator controlled trolley characteristics with constant-potential characteristics.



speed, the peak plugging torque obtained with constant-potential may be approximately 160 per cent of the motor one hour rated torque. However, the plugging torque and the rate of deceleration will decrease until the speed is slow enough to permit short-circuiting the first resistance step. In comparison, the torque limiting rotating regulator control will bring the trolley to rest in a shorter distance, and the relatively constant torque can be less than the peak value obtained with a constant-potential drive. Furthermore, in order to provide rapid deceleration when the rails are dry and still prevent wheel slippage when the rails are wet, the ratio of the plugging torques on the slow speed and full speed points in the rotating regulator control can be made the same as the ratio of the coefficients of friction for wet and dry rails.

5. An adjustable-voltage installation will consume less power than a constant-potential installation since there is almost no power loss in resistors. A comparison between two coal unloaders with the same hoisting distance and the same guaranteed tonnage per hour showed the a-c rheostatic unloader using 1.21 kwhr per ton and the adjustable-voltage unloader 0.62 kwhr per ton. The maximum power demand peak for the adjustable-voltage unloader was only 75 per cent of the a-c rheostatic peak. The same principle of power loss in resistors on the a-c rheostatic unloader would apply to a d-c constant-potential installation, which would also have additional power dissipated in resistors when lowering at full speed.
6. There is less maintenance expense for the electrical and mechanical equipment on an adjustable-voltage installation than on a constant-potential installation. Twenty-four years after the above mentioned coal unloaders were placed in service, a survey made by the owner showed that the maintenance expense for the adjustable-voltage unloader had been negligible in comparison with the a-c unloader.

BLAST FURNACE SKIP HOIST

Continuity of skip hoist operation is essential for a successful blast furnace installation; therefore reliability and flexibility are of primary importance in selecting the drive system. Since the cost of the electric equipment is a very small percentage of the total furnace cost, there is a definite tendency to incorporate features that will permit continuing operation under almost any emergency condition. Figure 11 shows the basic circuit that has been selected by several steel mills in the United States and in Canada during the past few years to provide the following features:

1. The two-motor drive with separate motor-generator sets and transfer switches makes it possible to operate the hoist at approximately 60 per cent speed with normal loads by connecting either motor to either generator.
2. The motor-generator set driving motors can be connected to independent buses to permit continued operation in the event of a power failure.
3. Two separate rotating regulator sets are available, each capable of exciting both generators.
4. The excitation and control circuits can be connected to either the 250-volt mill bus or a constant potential exciter.
5. The control has been simplified and load division assured by connecting the hoist motors and generators in a series loop circuit for normal operation.

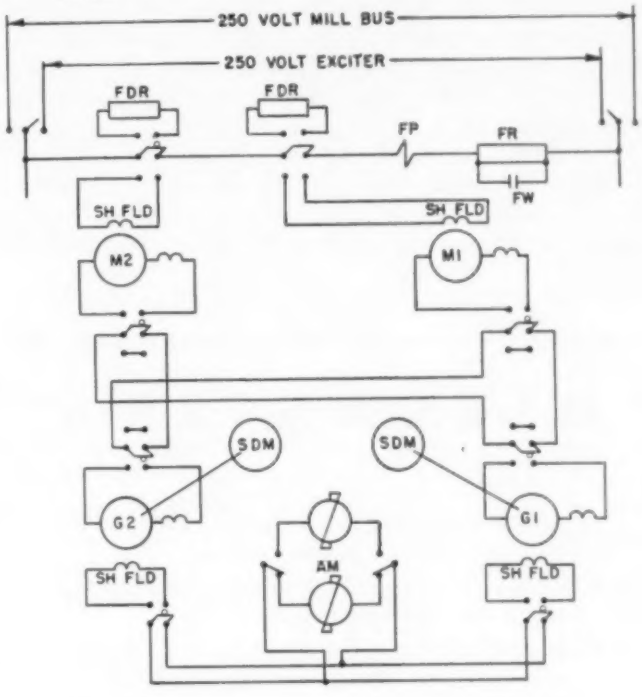


Figure 11 — This basic skip hoist circuit has been used in a number of installations in the past few years.

Rotating regulator control has been applied to the distributor at the top of the furnace in order to obtain approximately constant speed for the variety of angular rotations required and the wide range from light coke loads to heavy ore loads. Program control, utilizing industrial type automatic telephone relays, sequences the loading of coke, stone, and ore in accordance with a pre-selected pattern for charging the furnace.

SUMMARY

Electric power, either from batteries or diesel-generators, is permitting the manufacture of trucks for an ever increasing number of steel mill applications.

As far as conveyors are concerned, there appears to be two definite trends. One trend is toward the use of standardized components, such as motor control centers for squirrel cage motors with push button and indicating light assemblies, as used for the San Vicente installation. The other trend is toward adjustable-voltage speed control, either by the use of speed-variators for relatively simple installations, or by the use of ro-

tating regulator control to provide the utmost in flexibility as in the Orinoco loading station installation.

For cranes, the trend is toward increased safety—by providing for safe lowering of heavier overloads—by including slow light-load hoisting speed points without encountering the possibility of snapping the cable when the power limit switch trips—and by preventing a motor run-away if the power limit switch fails to reset when accelerating out the "limit switch zone." Bridge and trolley plugging performance has been improved. Creeping speed control is being provided on high-efficiency bridge and trolley motions, when required, by an armature shunt connection on the first one or two speed points.

An increasing number of bridges and unloaders are being constructed with adjustable-voltage drives. When considering the purchase of a new bridge or unloader, a comparison between adjustable-voltage and constant-potential should be made to consider total over-all installed cost, expected life of any existing power conversion equipment, average cycle time, maintenance costs, power costs and operator fatigue.

Blast furnace skip hoist drives are being made more reliable and more flexible by the two-motor drive with separate motor-generator sets, rotating regulator control, and co-ordinated program control.

Considerable progress has been made toward the goal of obtaining improved performance and increased safety from materials handling machinery.

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DISCUSSION

PRESENTED BY

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B. S. JACKEWICZ, Sales Engineer, The Electric Controller and Manufacturing Co., Detroit, Mich.

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M. J. MILLER, Superintendent Maintenance, Blast Furnace and Coke Ovens, Ford Motor Co., Dearborn, Mich.

L. H. Romzick: The statement made about improving jogging performance for crane hoist control is quite broad and general. I wonder if there are any facts to back that up?

S. Rifkin: There is a test tower at the factory on which tests were made of various existing circuits and the new hoist circuit. With a previously accepted circuit and 117 per cent load on the hook, the average rotation of the motor shaft for jogging in the lowering direction was 400 degrees, and with the new circuit the average rotation was 73 degrees. In the hoisting direction, the load actually dropped an average of 288 degrees when jogging with the previously accepted circuit; whereas the new circuit would provide an average rotation in the hoist direction of 46 degrees. Those are some figures to back up the statement of improved jogging accuracy.

B. S. Jackewicz: When you refer to jogging, do you mean using the hoisting for so-called inching?

S. Rifkin: That is right.

B. S. Jackewicz: Is that not primarily a function of the electric brake, how fast it releases and sets?

S. Rifkin: If the competitive tests are made with exactly the same brake and motor, a comparison can be obtained of the jogging accuracy provided by various control circuits. Undoubtedly the setting speed of the brake has some effect on jogging, but so do the "kick-off" torque and motor speed provided by the control circuit.

Henry C. Keiser: How can you claim reduction in maintenance expense for the adjustable voltage unloaders when there is so much heavy rotating equipment?

S. Rifkin: That has been one of the major points that the steel industry has been concerned about. On constant-potential ore unloaders, there are many large heavy power contactors that are continuously interrupting the power circuit. On the adjustable-voltage unloader, there are small devices handling field currents; and, under normal operating conditions, the heavy power circuit is never opened; so you have considerably less control maintenance.

The adjustable-voltage coal unloader that I mentioned operated for 19 years before the motors and motor-generator set were overhauled as part of a preventive maintenance program. TVA's Johnsonville coal unloader, which has a free-digging capacity of a thouhand tons per hour, operated over a year with the only electrical maintenance being the replacement of two brushes on the generator. They had not touched the commutators of the motors or generators. They had not touched a single control device. That is the basis for claiming decreased maintenance expense, both in mechanical and electrical equipment, with an adjustable voltage drive.

M. J. Miller: How does the initial cost of the two-generator skip hoist job compare with the single motor, single generator job?

S. Rifkin: There is no doubt that a two-motor generator set drive for a skip hoist is more expensive than a single motor drive would be. However, the cost of the electrical equipment on a blast furnace is an extremely small percentage of the total overall cost of that blast furnace. It only takes one shutdown of a blast furnace to justify a considerable amount of higher initial cost for a system which would have avoided that shutdown and allowed production to continue.

Production of Aluminum Foil

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. . . . the foil mill is a monument to the rolling mill engineer's ingenuity . . . .

▲ THESE comments are my own observations on personal experience in the manufacture and production of aluminum foil. This subject should be of interest to persons who may be contemplating going into the rolling of thin metals, not only of foil, but all metals of light gauges. The returns which can be and are realized in the production of metal specialties afford one of the most profitable of all re-rolling programs. Indeed the returns from this field, when handled by men who have executive ability, have been one of the most fantastic successes in the rolling industry.

The writer does not claim any personal credit for

Figure 1 — Shown here are 3 stands of a 5-stand tandem mill setup. This is not a tandem mill in the strict sense of the word as the stands can be worked independently and transmit the coil from one reel to another.

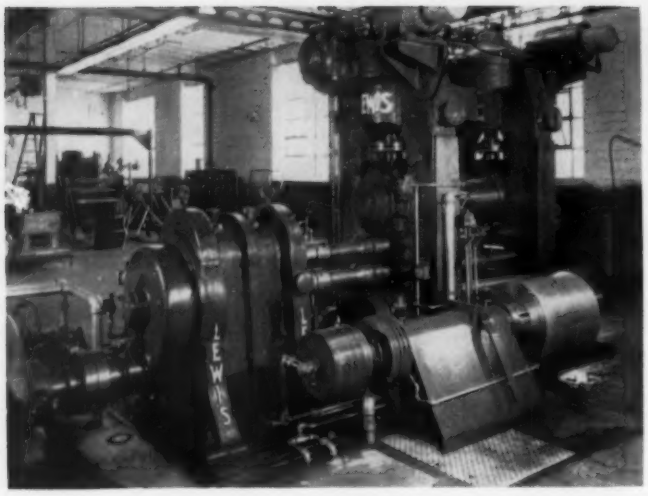


Figure 2 — Shown here is an enlarged view of the first stand of the mill illustrated in Figure 1.

the very profitable returns from this business excepting the pride we take in adapting the developed ideas from steel and allied industries to the production of aluminum strip. Truly our customers have achieved a remarkable success in their plants. To them I attribute the remarkable success of the equipment.

The tremendous advance in the production of aluminum is the outgrowth of two wars in the present generation, and the energy and foresight of the men in the production of aluminum. As abundant as aluminum is in the earth—scientists estimate 25 per cent of the earth's crust is aluminum—the United States is one of the have-not nations, as far as high grade bauxite deposits are concerned. This condition makes our achievements all the more remarkable.

Aluminum foil, the subject with which I am dealing, is one with which the average man is quite unfamiliar. Its world consumption is a very small percentage, being measured in pounds rather than in tons. The shortage of tin is also critical. Aluminum is the only metal that can even approach tin in the processing and preservation of food. The production of aluminum foil was, I believe, first accomplished in Germany, in the early twenties. The first mills were 2-high, 10 and 24-in., with speeds up to 200 fpm. Little or no improvement was made in the production of the mills or the rate of production until about 1936, when several 24-in. 2-high mills were equipped with oil sleeve bearings. It was about 1936 when the first 4-high mills were installed for the rolling of aluminum foil. Adaption of the modern features of the 4-high mill enabled the producers to greatly increase the speed of rolling. This, in turn, created a demand for large coils which were heretofore on the order of 200 lb. These soon increased to 500, then to 1000 and 2000-lb coils.

The first aluminum foil was produced by ALCOA in 1913; second, in 1923, by the Conley Foil Co., who were taken over by Lee Myer & Schwartz, who were in turn bought out by Reynolds Metals. They operated as the U. S. Foils Co.

The popularity of aluminum foil has increased tremendously from 1936 to 1952, due mostly to the improvement in the manufacture of mills of greatly increased daily output. The demand for foil has increased 1000 per cent. We have turned out over 100 modern foil mills of 4-high construction, which have incorporated all of the latest modern features, both electrical and mechanical, and many new ones to come.

The original foil mills were low-powered and of low speed, and as far as heat control was concerned, none was required, as the low speed depended on the mass of the rolls and mill frame absorbing the heat generated.

With the development of modern mills, including the last word in bearings and electric tension control, it became immediately necessary to add thermal heat absorption and control. This made it possible to vastly increase the speed, and the weight of the coils being rolled. The thermal control is the last word in rolling efficiency. It enables the rolling of extremely thin metal at lower maximum tension and the production of full coils, evenly balanced in tension and with scarcely any breaks—full coils and greater weights—3000 to 3500-lb coils are being rolled regularly.

I do not intend to make this paper a strictly technical discussion of the manufacture of foil or thin metal. It is presented for the layman who is interested in the many uses of aluminum, which is, except for gold and silver, one of the most ductile of all metals, and cer-

TABLE I

Pass Schedule — 9 & 21 x 44 in., 4-High Aluminum Mill
Width 37 in., Thickness from 0.030 in. to 0.00035 in.

Pass	In	Out	Draft	Per cent reduction	H1/R		Arc	Area	Resistance	Pressure	Pressure per 1 in. width	Hp at 100	Speed fpm	Motor, hp	1544-ft Length entering	Time, min
										lb						
1	0.030	0.018	0.012	40	0.0067	1.666	0.233	8.62	40,000	345,000	9,324	54	250	135	2,570	10.2
2	0.018	0.009	0.009	50	0.004	3.33	0.202	7.47	50,000	375,000	10,100	50	300	150	5,160	17
3	0.009	0.004	0.005	55.5	0.002	7.50	0.150	5.55	70,000	390,000	10,400	39	400	156	11,600	29
4	0.004	0.0018	0.0022	55	0.0009	16.6	0.100	3.70	90,000	334,000	9,010	22	800	176	25,700	32
5	0.0018	0.0008	0.0010	55.5	0.0004	37.5	0.067	2.47	95,000	234,000	6,350	10.5	1300	136	58,100	45
6	0.0016	0.0007	0.0009	56	0.0004	42.8	0.064	2.37	95,000	225,000	6,100	9.5	1360	129	66,100	49

The pass schedule can be exceeded continuously for hp input 10 per cent.
Indicated loads are normal and do not indicate the 10 per cent.
Mills as geared now permit No. 1 mill 180 hp at 250 fpm, No. 2 mill 220 hp at 490 fpm; No. 3 mill 721 hp at 220 fpm.
Pass schedule is based on 2000-lb coils. These reductions are practically a standard for all four-high, 5-stand setups.

TABLE II

Pass Schedule — 9 & 21 x 44-in., 4-High Aluminum Mill
Width 36 in., Thickness from 0.026 in. to 0.00035 in.

Pass	In	Out	Draft	Per cent reduction	H1 / R	E L	Arc	Area	Resistance	Pressure, lb	Hp at 100	Speed, fpm	Motor, hp
1	0.026	0.010	0.016	61.5	0.006	2.6	0.269	9.70	40,000	384,000	70	250	175
2	0.010	0.004	0.006	60	0.0022	6.5	0.164	5.90	50,000	295,000	33	300	100
3	0.004	0.0018	0.0022	55	0.0009	14.5	0.100	3.60	70,000	252,000	17	800	136
4	0.0018	0.0008	0.001	55.5	0.0004	32.5	0.067	2.40	90,000	216,000	10	2000	200
	Double	rolled											
5	0.0016	0.0007	0.0009	56	0.0002	74	0.064	2.30	95,000	218,000	9.5	2000	200

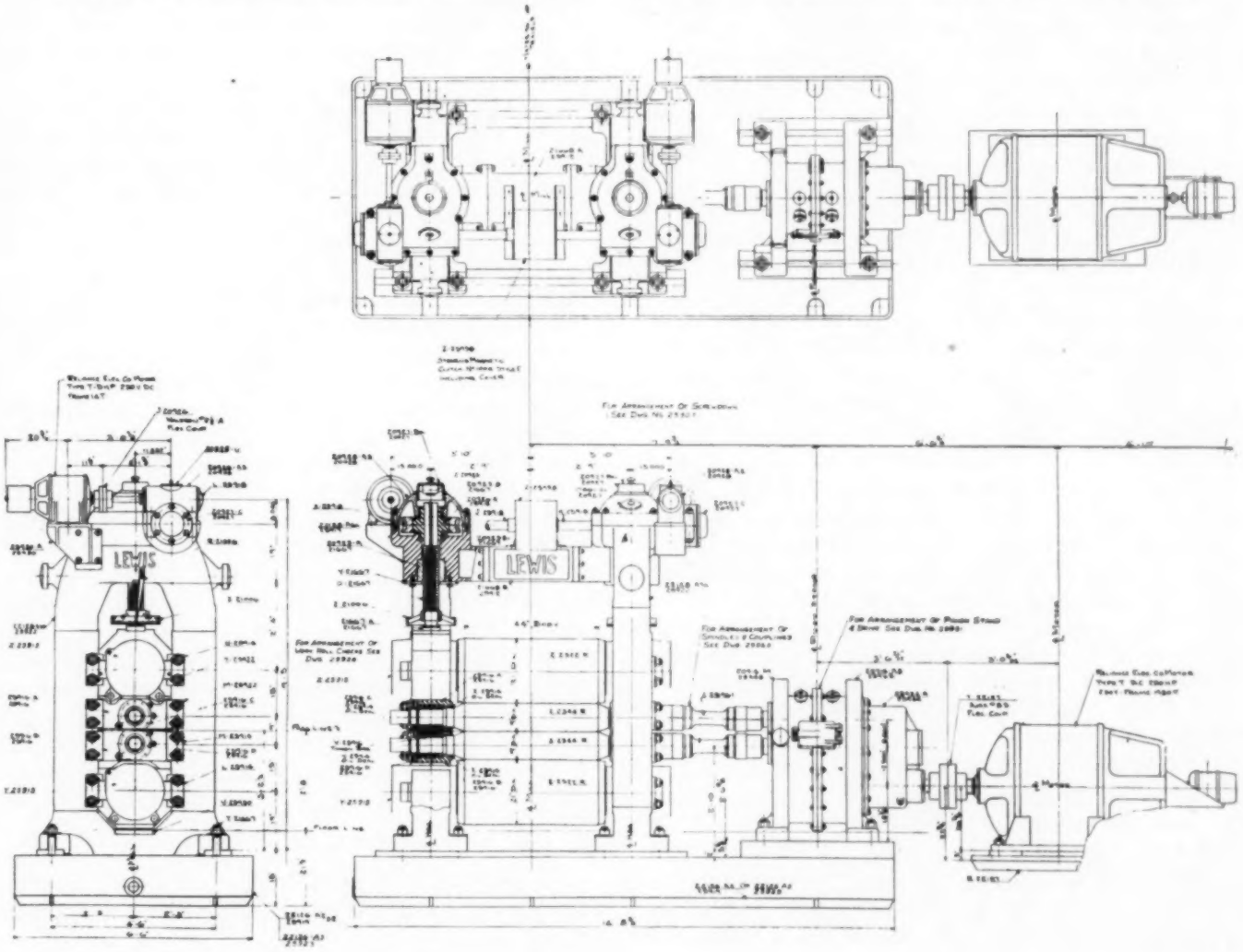
The gearing as now set permits speeds as shown. No. 1 mill takes the first two passes in every case.
Balance of rolling to take 3 or 4 passes on 2, 3, 4, 5 mills to 0.00035 at the discretion of the operator.
Pass schedule is revised to suit heavier passes at No. 1 mill.

tainly one of the most abundant of all metals of this type and the one most widely used.

ALUMINUM FOIL USES

Aluminum foil uses are still more or less in the development stage. The cigarette trade probably originally accounted for a large part of the aluminum produced at one time. At the present time, many products have found the aluminum wrapper ideally suited as a container and preservative. Examples are: dried fruits, soups, pie plates, household wrappers, candy wraps, cheese and numerous dairy products, holiday ornaments and wrappings, tea, coffee, sugar, chewing gum and a multitude of food products, heat insulation, wall insulation, wall lining, radio condensers and other

Figure 3 — Drawing shows general arrangement for No. 1, 2 and 3 Mills of 9 and 21-in. x 44-in., 4-high foil mill.



types of radio units containing insulation, and many thousands of lithographed labels and beer bottle labels. Other applications are many forms of one-time containers, pie plates and frozen food containers; also foil threads woven into ladies' garments and yard goods, particularly draperies. The development of new uses for foil has been very enthusiastically received, and one popular application is the use of household wrapping foil rolls of 25 and 50 ft.

THE MODERN FOIL PLANT

A modern foil plant today would consist preferably of five 4-high mills, either 9 and 21 x 44 or 10 and 24 x 48 in. This, of course, would vary according to the immediate rolling program. There appears to be considerable interest in wider foil up to 60 in. Whether the demand will justify a number of installations of this width at the present time depends on the lithographing and printing trades which at the present time are not set up for over 37 in. wide.

Normal equipment for these mills requires preferably the inclusion of lubricating equipment for oil sleeve backup roll bearings and a complete thermal roll cooling system equipped to regulate the roll contour to fit the entire rolling program. This should be able to absorb the generated heat and maintain the roll contour so accurately that practically straight ground rolls can be used on all of the mills, requiring only the regulating of grinding so that the two last mills will have highly polished rolls for the last single and the doubled pass. The other three stands would be ground with 250 and 350 grit wheels with the two last stands, No. 4 and No. 5, ground with 350 and sometimes 400 grit stone. It is seldom that a finer grit stone need be used.

The thermal cooling system, to which reference has already been made, is the key to successful operation and high yield in foil rolling. Full temperature regulating valves and spray pipes are supplied so that very accurate regulation of the cooling and lubricating oils is always under instant control. Full temperature control is provided on the work rolls, the backup rolls and the backup roll neck temperatures. Provisions for slight changes in contour and temperature control is at the operator's control at all times.

The cooling oils for each mill are in individual tanks, two for each mill, and are usually mixed specially for each pass. The filtering of the oil is also graded according to the position in the operation on all passes. Piping is maintained to Fuller's earth filters where necessary. However, much of the operation requires only mechanical filtering to keep heavier particles from marking the breakdown passes. The extreme filtering with Fuller's earth is required only on the last single and the double pass, as a general rule.

The general cooling oil is fully satisfied with a clear water white distillate with palm oil addatives. There are many oil compounds being used, none of which are any better than a suitable amount of palm oil addition.

The reason for usually confining the Fuller's earth to stands 4 and 5 is that it takes out a large part of the palm oil with the aluminum oxide. The kerosene distillate is fully recovered, but the deficiency in palm oil must be made up when it gets too low.

Rolling aluminum is an operation largely made with tight screw application.

The later passes are heavy enough to cause considerable flattening of the arc of contact. The result is that unless careful judgment on very thin metal is used, actual pressure increases can get to a point where less reduction is realized than less pressure will produce. This is the reason the smaller the work roll down to well known proven diameters, the better the mill will roll. There is another limiting factor — the thermal stability of the roll. Its capacity to transmit a certain portion of the rolling heat must be considered.

Copius quantities of cooling oil are applied, but we have found that a 9 or 10-in. roll performs much better on a given mill than a 7-in. roll under the same conditions.

Also, we have to recognize the power the work roll neck will transmit. The torsion factor must be kept low enough to insure a full life to the rolls without fatigue failure of the necks. This, of course, means the power applied limits the motor and roll speed to that which the work roll will stand.

I might add at this point that the successful operation of the mill is greatly benefited by equipping the finishing mill and the last single pass mill with pressure gauges under the screws. This enables you to determine accurately when you are rolling the strip at maximum efficiency and not flattening the roll arc of contour far beyond the maximum effective pressure. This can very easily happen in skin friction on very thin metal.

Another factor should be taken into consideration. Up to a certain point, foil mills work better hot than when drowned with oil to cool them down. Work rolls can run up as high as 280 F with the backing rolls correspondingly hot, and give excellent results. In fact, we have in many instances omitted the usual flash anneal before the last pass. The only limiting factor is the flash point of the cooling oil. This must be carefully checked. Otherwise no other precautions need be taken.

Normally hardened steel rolls do not lose their surface hardness unless they pass the 300 F line.

All spare rolls not in use and ready for the mill should be kept in an oil bath at a temperature of about 200 to 219 F, especially in winter, as it takes the shock out of the roll surface when mill rolls are started up after a roll change. The backing rolls are normally equipped with oil skimmers or wipers to keep the rolls clean.

The mills are all equipped with deflector rolls to guide the strip on and off the winding and unwinding spools. The mills are usually fitted with cone type winders and unwinders, excepting No. 1 mill which is fitted with a roller holdback and an expanding mandrel unwinder with an adjustable centering device on the wind-up side. A cone-centered tubular spool and air brake back tension are also provided on each mill, with suitable tension control. In a 5-stand mill 10½-in. tubular spools are usually provided. A few installations have been equipped with 20-in. spools. This cuts down the percentage of electrical build-up ratio and improves the general sensitivity of the tension control in large coils.

TECHNICAL PROGRAM

of the

AMERICAN IRON AND STEEL INSTITUTE

. . . . in reviewing problems of iron and steel production, leading operators of the steel industry, at the sixty-first general meeting of the American Iron and Steel Institute held in New York City on May 27 and 28, 1953, presented a number of interesting papers . . . . special panels were held on foreign practices, metallurgy, testing and inspection, and iron and steel . . . . because of their value to industry, some of the papers are abstracted here . . . .

"RESEARCH AND THE MINOR CONSTITUENTS OF STEEL"

By JOHN CHIPMAN

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▲ THE chemistry of steelmaking is concerned with a large number of the elements, including iron, the alloying elements, the impurities, the special additions such as deoxidizers and those elements which constitute refractories, slags, fuels and gases. It is a broad field, but for our present purposes I wish to direct your attention to the important part played by the minor constituents of steel. Herein lies the heart of nearly every problem of steelmaking chemistry.

These minor metals in steel are not always harmful, not always beneficial. In fact, one must go a long way down the list before he encounters one such element which is either wholly good or wholly bad in steel. Some of these minor elements are spoken of as "impurities" with the definite implication that they are undesirable, and we make additions that are sometimes called "scavangers" in an effort to clean out the so-called "dirt."

The practical art of steelmaking will be enhanced if we think less of the "elimination of impurities" and more of the scientific control of composition, including the minor constituents. The control of the major constituents, iron, carbon, manganese and the alloying elements when present by intent, is generally a mere matter of good melting practice and of correct weighing and addition with the proper recovery factor. But the control of minor constituents turns out to be a matter of applied chemistry and our success in maintaining a desired composition hinges upon our mastery of a chemical process.

SULPHUR

Let us consider the overall problem of control of sulphur in the product of any typical steel plant. The experience of others and the laws of chemistry discourage us from trying to drive the sulphur to a lower level than is needed for the intended product. Yet some must be removed since raw materials contain more than most products will tolerate. Shall we make our attack upon the coke or upon the product of the blast furnace? Shall we desulphurize the hot metal while it still contains its carbon and silicon or wait until it is converted into steel in the open hearth and then work on it with slag additions? Which is the easier job?

Studies of sulphur removal by means of hydrogen gas show (1) that hydrogen is not a very good desulphurizer and (2) that it is more successful in removing sulphur if the metal contains substantial amounts of carbon, silicon and phosphorus. The effects of these elements are cumulative and, if the metal is of normal pig iron composition, the gas finds it possible to remove sulphur five or six times as easily as it could from a low carbon steel of like sulphur content. This is not a property of the gas but of the metal and any desulphurizer would find it five or six times as easy to remove sulphur from pig iron as from low carbon steel.

But this is only a part of the story. If we depend upon a slag for sulphur removal we must realize the fact that small amounts of iron oxide in the slag have an enormously deleterious effect upon its desulphurizing power. If the iron oxide can be held below one per cent, the

sulphur-holding power of the slag is increased and this leads to very efficient desulphurization under slags like those produced in the blast furnace. It is quite impossible to produce open hearth slags of sufficiently low FeO to utilize these higher desulphurizing powers. It is even a rather difficult job in the electric furnace.

It is thus seen that there are two chemical reasons why the blast furnace has an enormous advantage over the open hearth as a desulphurizer: the first that the metal gets rid of its sulphur more readily; the second that the slag holds more.

Removal of FeO, MnO and of other sources of oxygen by addition of strong deoxidizers can accelerate the desulphurizing action of blast furnace type slags. There is a further consideration which also favors hot metal desulphurizations. This is the fact that it can be brought into reaction with solid lime and effectively desulphurized by this cheapest and most efficient desulphurizer.

PHOSPHORUS

The outstanding fault of phosphorus has always been to render steels brittle under shock. At the same time the static ductility might be unaffected or lowered in a most erratic manner. Today we would summarize these complaints by saying that phosphorus raises the transition temperature in a most undesirable manner. When this effect is offset by alloying additions some rather useful low alloy-high tensile steels can be obtained. This fact and the increased hardenability attainable suggest a re-examination of the effects of this minor constituent in the light of modern methods.

With respect to the control of this element, it has long been known that its efficient removal requires slag of high basicity and high iron oxide together with low temperature.

NITROGEN

It has been known for many years that bessemer steels are high in nitrogen, and it has been generally assumed that this element accounts for differences between bessemer and open hearth steels. This is a dangerous oversimplification, however, since there are other differences as well as in nitrogen content. Another important difference is in the phosphorus content, which is normally much higher in bessemer than in open hearth steels. It has not been fully appreciated until rather recently that nitrogen and phosphorus work hand in hand. The outstanding effect of nitrogen lies in its tendency to accentuate the aging characteristics following cold working of steel. This leads to a loss in toughness as measured by Izod impact strength. It is stated by Enzian that with 0.004 to 0.006 per cent nitrogen, variation in phosphorus from 0.15 to 0.120 per cent resulted in a change in strain sensitivity covering the full range from exceptionally insensitive to very sensitive behavior. On the other hand, the higher nitrogen steels, even those of low phosphorus content, seem to be inherently sensitive to cold working.

In certain applications the increased susceptibility to strain aging is a very valuable property and for this purpose nitrogen can be added successfully to open hearth steel. Instead of the usual 0.003 per cent nitrogen of open hearth steel, if this element is increased to around 0.010 per cent, the requisite stiffness of tin plate can be obtained with substantially less cold reduction. It is interesting that for use in the ends of beer cans, for which greater temper hardness is required, 0.015 to 0.018 nitrogen facilitates meeting the specification.

Bessemer type steel has always been famous for its good machinability. Again nitrogen is in part responsible and the characteristics of this type of steel can to some extent be approximated by increasing the nitrogen content up to about 0.020 per cent. This increased nitrogen content is usually obtained by the addition of calcium cyanamide to the ladle where the added carbon can be tolerated, or by use of ammonium sulphate if the increased sulphur content is desirable.

Nitrogen also finds considerable usefulness in stainless steels. Here it is usually added as high-nitrogen ferrochrome for the purpose of refining the grain or of stabilizing austenitic stainless steels. Its ability to stabilize austenite becomes extremely important in view of the scarcity of our old reliable austenite stabilizer—nickel.

The industry is perennially plagued by a group of minor constituents that we generally classify as residuals. These elements accumulate in steel scrap, some having their origin in iron ores, but more generally coming from admixture of alloy and nonferrous scrap. How wonderful it would be if some smart chemist could find a way for removing copper by some modification of the open hearth process! The sad fact is that no such method is ever likely to be discovered. Copper is less active chemically than iron. All methods that have been dreamed of to date remove more iron than copper! A similar situation pertains to nickel and molybdenum. We are learning to live with these intruders and, when that is impossible, to exclude them by increased use of virgin materials.

The case of chromium is an interesting one. This is a very common ingredient of alloy scrap and occasionally appears in alarming proportions where it is least desired. Removal during open hearth refining is incomplete since the reaction is limited by approach to equilibrium. Recent studies indicate that slags are limited in the amount of chromium they can absorb. For best efficiency of removal there is little that can be done beyond the use of slags of high iron oxide content.

OXYGEN

As a cross-section of the current status of oxygen-in-steel research let me mention a few recent investigations.

The entire operation of the open hearth furnace hinges upon the chemical reaction of carbon and oxygen in the liquid steel, producing carbon monoxide which gives rise to the "boil." As carbon decreases so oxygen increases and in low carbon steels we find the highest quantities of oxygen.

When alloying elements are present in the steel bath, the behavior of oxygen may be markedly affected. For example, in a bath containing six per cent chromium the activity of a given percentage of oxygen is only half of its normal value in unalloyed steel. This means that in order to decarburize chromium steel to a specified

low level, a higher oxygen content is necessary, and final deoxidation is correspondingly more difficult.

Similar and even stronger effects are reported in vanadium steels by Dastur and in silicon steel by Gokcen. We are barely beginning to uncover the many inter-relationships between oxygen and other constituents.

A number of elements which form stable oxides are used in steel as deoxidizers. Manganese rates as about the weakest while zirconium and aluminum vie for the rating of most potent in general use. No deoxidizer is able to remove all the oxygen from steel.

Most of the nonmetallic inclusions in steel consist of the oxides of the deoxidizing elements. When the deoxidizer is added, a considerable amount of oxide is formed immediately. Most of this floats out rapidly but some of it may remain in the steel. Now, as the steel cools and solidifies the solubility of the oxides decreases and hence more non-metallic matter is thrown out of solution. This same thing happens to the sulphides which are not very soluble in solid steel and therefore come out of solution as the metal solidifies. The resultant nonmetallic inclusions are trapped among the growing crystals of the solidifying steel. They consist of the sulphides and oxides of iron, manganese and the deoxidizers added, and the inter-relation between them is of great importance to the properties of the finished steel.

CARBON

We do not generally think of carbon as a minor constituent but in transformer sheet and in low carbon stainless it is exactly this. In the remelting of chromium-bearing scrap, removal of carbon is limited because the solubility of oxygen is very low in the presence of chromium. Here is a typical case of an interaction between the minor constituents, carbon and oxygen, which is controlled by the fact that both react with the allowing element, chromium. I have already mentioned the chromium-oxygen relation and will only add that the similar chromium-carbon interaction has been worked out by Richardson and Dennis. Very high temperatures are needed to remove carbon in the presence of chromium. Herein lies the supreme advantage of oxygen blowing, which supplies simultaneously oxygen, temperature and agitation of the bath.

HYDROGEN

The current villain of the steel mill is hydrogen. This element occupies a position today in many ways comparable to that of oxygen 25 years ago. His ways are mysterious, his intentions are subversive, his effects pernicious. The only reason we have been able to live with him so long is that he is generally present in steels in amounts of only a few parts per million.

Hydrogen has been convicted of such crimes as fish eyes, flakes, shatter cracks and transverse fissures, although, of course, in some cases there have been comalefactors who shared the guilt. Hydrogen is an uninvited and unwelcomed guest whose inroads are expensive to his host. He is able to find his way into the steel bath even when it is guarded by a heavy slag. And it is because of his presence that we must resort to extreme measures for slow cooling of heavy sections of many grades of steel. The only kind words I have heard concerning this reprobate are that he provides a cloak for ignorance or is a scapegoat for metallurgical sins and that he is too elusive to be caught in a specification.

Hydrogen is indeed a current problem and of all the minor constituents it is probably the one we know least about. Until recently there have been no satisfactory analytical methods for hydrogen and much of what we do know has been deduced without benefit of analysis. From the standpoint of its control in steelmaking processes there has been one rather serious stumbling block in the path of progress. A sample of liquid metal taken from the furnace loses hydrogen on freezing. Even if this is prevented by ultra-rapid quenching, the sample can lose hydrogen in ordinary storage. In order that the analysis correspond to the actual hydrogen content of the steel bath, the sample must be quenched rapidly to dry ice temperature and held there until analyzed.

Progress is being made rapidly at the present time and it seems now that the stage is set for clearing up the many remaining mysteries of the effects and control of this constituent of steel. One of the promising avenues of study is, as in many problems of steelmaking, in the slag. The evidence seems to indicate that hydrogen penetrates through the slag into the metal and a program of research is under way in which it is hoped to find what kinds of slag offer the best protection. There are grounds for suspecting that it may be water rather than hydrogen which is able to dissolve in slag and diffuse through to the metal where it reacts to form hydrogen.

"REVIEW OF EUROPEAN OPERATING AND TECHNICAL PRACTICES"

By WILLIAM C. BELL

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▲ THE European countries in 1952 made some 53,900,000 net tons of pig iron and 68.1 million tons of ingot steel; in all, about a nine per cent increase on 1951 production and a new record output.

IRON ORES

About 43,000,000 tons Fe were made available in Europe in 1952 by the mining of 113,000,000 tons of ironstone; the overall Fe content was only 38 per cent. The total Fe produced was clearly not sufficient for the pig iron production of 53,900,000 tons, for Europe as a continent is an ore importer, requiring supplies from Algeria, Tunisia, Newfoundland and some of the South

American countries. The imported ores are absorbed mainly in the United Kingdom, Western Germany and France. These supplies have to be kept in economic balance with the European coke supply position.

Only about 12,500,000 tons of the 43,000,000 tons Fe arising in Europe came from high grade ores, principally the Swedish magnetites. No less than 28,000,000 tons, or two-thirds, came from ores of not more than 35 per cent Fe.

It is important to add that most of these low grade ores are phosphoric with about 0.6 per cent P. On the basis of 2½ to 3 tons of ore per ton pig, it is an uncertain business for most blast furnace managers to satisfy the not unreasonable requirements of their colleagues operating open hearth plants. It is essential to emphasize the very important, and increasingly important, position of the basic bessemer or Thomas steelmaking process in the European iron and steel industry.

The best metallurgical practice in sintering is usually thought of as that in Sweden, and, nowadays, Swedish blast furnaces are burdened almost entirely with ores and concentrates in sintered form. This, understandably, has resulted in very high iron productivities per unit of furnace volume and indeed 4.4 tons per day per 100 cu ft volume have been reported.

Most European countries are at present increasing their sintering capacity, mainly with continuous strands of higher ratings in lengths of up to 120 ft. The general preference for the 72-in. strand remains, although the German plant at Watenstaedt is unusual in having a strand width of 99 in.

A characteristic of many of the European low grade ores is that on sintering there is a loss of combined CO_2 and water of about 30 per cent of the ore weight. Thus a dual purpose is served, for the necessary aggolmeration is accompanied by an increase in Fe content although not, of course, by any change in the iron/gangue ratio. Further, the mineralogical nature of many of these ores is such that the formation of some slag during the sintering process is unavoidable and, indeed, may be necessary to give strength to the product. It follows that, because of the shrinkage on sintering, close attention is necessary to the size grading of the raw mixture of ores, coke and returned sinter fines.

In Luxemburg, the agglomeration of ore fines into nodules has been developed in preference to orthodox sintering practice. The principal reasons are that in Luxemburg a sufficiency of blast furnace gas is available but the supply of coke breeze is limited. The rotary kiln process has been applied commercially to a mixture of 30 per cent minette fines with 70 per cent flue dust and also to a straight flue dust. Output rates of about 1000 tons per day have been obtained from the kilns which are, typically, about 200 ft long and 11 ft in diameter. The quality of all the nodules, in terms of strength, porosity and reducibility are regarded in Luxemburg as fully equivalent to that of sinter. The process has the advantages of a relatively low power consumption and a high labor productivity. The main operating trouble has undoubtedly been that of preventing down-time through accretions building on the kiln walls; to obviate this, water-cooled retractable craper probes are used. This device is usually brought into action once or perhaps twice per shift while the kiln remains in operation.

PELLETIZING

The current interest, in Europe, in pelletizing processes, has been stimulated by the increasing proportions of fines in the ores available, and also by the need for an inexpensive method of agglomerating beneficiated ores, whether from imported or native supplies. The three methods of (a) briquetting in presses, (b) nodulizing in rotary drums and, more recently, (c) the use of extrusion augers, are being intensively examined and have been taken to the pilot plant stage in several countries. What is wanted from these methods is that they will agglomerate ore in an uprising size grading without the need for fine grinding, to say, 50 per cent minus 200 mesh; also that other burden materials might be taken into the agglomerate and, further, that preferably no binders will be necessary or, if binders are essential, they will be readily available, cheap and introduce no such complications as the acceleration of refractory attack by alkalies in the furnace. The newer briquetting techniques for ironstones are essentially an extension of the methods used in the past for coals, and developments are towards continuously operating automatic presses. Nodulizing processes have followed familiar lines. I pass these methods over with only a mention to give you a brief description of experimental work on vacuum extrusion in the company with which I am associated. The features of this development have been that neither binders nor plasticizers are needed, due to the clay-like characteristics of the Northamptonshire ironstone fines.

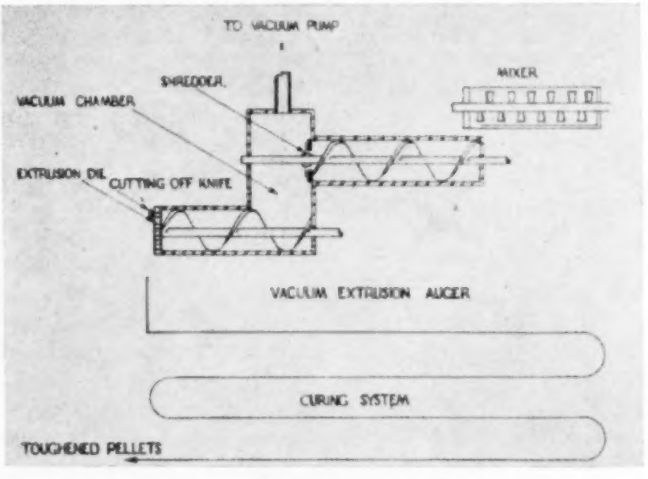

Figure 1 — This vacuum extrusion pelletizing plant has given successful results.

As many of these ores are relatively soft and friable, we have been able to process run-of-plant minus ¼ in. material, without a separate grinding treatment before the extrusion auger. A variety of pellet sizes has been made, between 1 in. and 3 in. cylinders, and for each the best moisture content is 16½ per cent. The pellets, after extrusion, are not dried but allowed to toughen up naturally, and within an hour are good burden material. In this toughened condition, the pellets withstand upwards of 8-6 ft drops without deterioration. A full-scale trial has been held, when 1650 tons of unfired pellets were taken by a 20-ft hearth diameter blast furnace over five days. These pellets provided about 17 per cent of the Fe charged, and the

furnace drove at a high output rate. A larger prototype production plant is due to operate this year, and will provide pellets for one of these furnaces up to the extent of its normal sinter intake.

It has also been found experimentally that these English ores will carry, as extruded pellets, up to 50 per cent of imported ores such as Sierra Leone and Kiruna fines or concentrates.

COAL BLENDING

While orthodox furnace operation is requiring a better quality of coke than previously available, the higher grades of coking coals are becoming scarcer. This is the fundamental coke problem in Europe. Larger tonnages of lower-rank coking coals will have to be used for the manufacture of metallurgical coke. The difficulties are being met by developments in the types of coals which may successfully be blended, and by providing controlled means of preparing the oven charge. Increasing attention is also being given to controlled heating rates during carbonization.

The best example of producing good metallurgical coke by careful blending techniques is undoubtedly the latest practice on the Lorraine coal field. Four grades of coal are involved.

ELECTRO-CARBONIZATION

The Norwegian experience in electro-carbonization has pioneered a method of beneficiation of coals, and this must have some influence on plans for iron-making where, at present, unorthodox practices are attractive. The high volatile, noncoking bituminous Spitzbergen coals have a volatile content of nearly 40 per cent with 5 per cent ash, less than 1 per cent moisture, about 54 per cent fixed carbon and 2 per cent sulphur. When carbonized in orthodox ovens, the coke is highly porous and of very low mechanical strength. In the electrical process the coal is first crushed and briquetted and the briquettes are preheated to 300-390 F by heat recovered from the exhaust gases. A charge of these enters a vertical shaft and descends at an even rate in countercurrent with gas at 1805 F. The exit gases leave at 390 F and are treated for by-product recovery. In this way a short ton of coal has yielded about 1,300 lb of coke briquettes, 20 to 50 gal of low-temperature coal tar of a high phenol content, and about 24,000 cu ft of gas (70 per cent H_2, 27 per cent CO) which is suitable for the synthesis of gasoline or diesel fuels by the Hydrocol process.

EFFLUENT TREATMENT

The disposal of effluent from coke ovens and gas-works has always presented a difficult problem, and particularly so in the case of plants situated in an inland location.

As in your country, impending legislation directed to the prevention of stream and river pollution has made this problem more acute with us, and a satisfactory technical and economic solution is sought.

Since 1947, experimental investigations have been carried out at Corby in cooperation with two other companies, and the scale of work increased until, at the present time, a pilot plant capable of a throughput of 350 to 500 U. S. gphr has been developed and is operating with a considerable measure of success. The pilot plant is designed to treat the effluent from the coke oven ammonia stills in two stages, to give a final effluent which is suitable for discharge into the main drainage system. In the first stage, thiocyanate and thiosulphate ions are removed by an ion exchange resin and concentrated in a small bulk of regenerant. In the second stage, phenols and tar acids are removed by activated carbon and recovered to give a saleable product.

The waste liquor from the coke ovens is collected in storage tanks, allowed to cool to 86 F and treated with acid to adjust the pH value to 6. This liquor is passed through a battery of three units containing an ion exchange material which has been loaded previously with hydrochloric acid. In this stage the thiocynate and thiosulphate ions are removed in exchange for chloride ions. When the concentration of thiocyanate in the bulked effluent from the ion exchange units has risen from an initially low value to a mean concentration of 0.003 gm/100 cc. the treatment is stopped so that the ion exchange material can be regenerated. For this purpose, a fixed volume of 12 per cent ammonia solution is passed through the ion exchange units in the opposite direction to the flow of liquor. This stripping wash removes the bulk of the thiocyanate and thiosulphate from the exchange material and is followed by two dilute ammonia washes and finally a water wash, all of fixed volume. The used strong ammonia wash is discarded but the three following washes are recovered for use in the next regeneration.

The volume of discard is about one-twentieth of the volume of liquor treated in the run so that a concentration of the noxious constituents into about 5 per cent of the original volume is achieved. The discard can be treated for recovery of the ammonia and finally disposed of by evaporation or other suitable means.

After the final water wash, the ion exchange material is treated with a fixed quantity of 3 per cent hydrochloric acid and is then ready to resume treatment of the effluent.

In the second stage of the process, a predetermined volume of liquor from the first stage is passed through two units containing activated carbon, which removes the phenols and other organic materials by adsorption. The carbon is then regenerated by passing fixed volumes of benzine vapor, followed by hot liquid benzene through the carbon. This treatment removes the phenols and most of the other organic materials. It is followed by a treatment with steam to remove the residual benzene, after which the carbon is ready to treat further a quantity of liquor. The benzene stripping wash, however, does not remove all the organic material and, in time, the carbon becomes fouled and needs replacing. It can be reactivated for further use but investigations are being made into the possibility of lengthening its life.

The benzene-phenol mixture from the regeneration is distilled to recover the benzene, leaving a residue of crude phenols which can be processed to give a saleable product.

We consider that the process developed has provided us with a technical answer to the problem of effluent disposal, though it is still a relatively expensive one. The effort is now directed towards reducing the cost of the treatment process and we are confident that this can be done.

Other methods of treating the effluent are being investigated. Experiments have shown, for example, that thiocyanate and thiosulphate are preferentially oxidized by ozone under the correct pH conditions, leaving the phenols almost unaffected. Ozone treatment, combined with the activated carbon process already described, would therefore give an alternative method for the complete purification of effluent.

IRONMAKING

The largest blast furnace in operation in Europe is a 27-ft hearth diameter stack at Shotton, England, recently brought in and expected to produce some 450,000 tons of iron per annum. A number of relatively large furnaces in the size range 25 to 28-ft hearth diameter have been planned and in some cases are under construction, particularly in the United Kingdom. In continental Europe the general type of raw materials supply and the prevalence of the Thomas steel process tend to limit upper furnace size to about 23-ft hearth diameter. Even so, the trend of development is towards larger blast furnaces, especially for operation on prepared burdens.

In Great Britain an 18-ft diameter furnace has been operating on the pressurized system for some time and has exceeded its previous record performance. Other, and larger, pressurized furnace installations are in course of construction.

Where cheap power is available from natural resources, the electric smelting process is used, in Norway exclusively and in Sweden and Italy to a substantial extent. At the Norwegian Mo-i-Rana plant, new Tysland-Hole electric pig iron furnaces will be in production this year. These furnaces, which will smelt a burden of concentrated and agglomerated domestic ores, will have nearly twice the capacity of any previous units (220 tons per day). This project is of general importance, being the largest example of fuel and power integration which is based on hydroelectric power and not on coking coals. The coke consumption per ton of iron will be less than half that of a normal blast furnace and, in addition, the furnaces will use a mixture of ordinary gas coke and coke breeze instead of high quality metallurgical coke. For each ton of pig iron the furnace will produce about 20,000 cu ft of 270 Btu gas, which cover all the reheating requirements of the integrated works.

In Sweden, where about one-fifth of the pig iron production is by the electric process, the Tysland-Hole units have largely replaced the older Electro-Metals furnace, the capacity of which was limited for technical reasons to about 55 tons per day.

In Italy, about one-quarter of the pig iron is made in electric furnaces and the development of hydroelectric power generating projects is continuing; for example, by the Falck Iron and Steel Company which generates about 700 million kwh from catchments in the region of the Ligurian Alps near Savona.

There are other examples of the more local utilization of relatively cheap power for ironmaking as in the Pyrenees in Southern France.

The 1000 tons per day blast furnace has come into European practice but, as mentioned, the greater majority of our furnaces have a lesser output. I should explain that per ton of iron the burden weights vary over a wide range; occasionally they are as low as about 4000 lb per net ton, but with our lowest grade of ores an upper limit of 6550 lb per net ton has regularly to be handled and smelted. Slag volumes, per net ton of iron, vary with the quality of the burden from 860 to 2150 lb and, in consequence, the coke rates also range between 1300 and 2250 lb per net ton of iron.

With the richest raw materials, European practice can show an economy and productivity which is indistinguishable from the high standards you have set up in the United States. To the case of Swedish practice which I have already mentioned, there could be added the further example of high productivity in the relatively small furnaces at Ijmuiden in the Netherlands.

If one had to choose a "typical" burden weight I should put it at around 5500 lb per net ton.

Carbon and China Clay Refractories—You will, no doubt, expect a reference to our experience in the use of carbon. Carbon crucible and bosh linings are now in fairly general use and show marked advantage over firebrick, at any rate in the crucible. The necessity to use carbon as a bosh lining is naturally not so marked. Experience with carbon hearth floors, particularly on our larger furnaces, cannot be described as so generally satisfactory, and current thought is that some form of under-cooling must be applied to ensure the successful application of carbon to this purpose.

Insofar as carbon in the stack is concerned, most of you know that stack linings of this type have been tried both on the continent of Europe and in the United Kingdom. Experience to date is by no means conclusive. There is some evidence that, in the lower two-thirds of the stack, carbon may be an advantage, but we have had a very mixed experience on carbon stack linings to date, and I would not attempt to report to you on this practice with any degree of finality at the moment. The possibilities of china clay for this purpose should not be overlooked.

In the United Kingdom the development of this material for furnaces smelting home ores has continued since 1939 when attention was first drawn to it in a Report to the Iron and Steel Institute. Recognizing that, in our view, carbon deposition round spots of nodular iron was the most important single factor in the disintegration of firebrick linings, and that from considerations of temperature alone most of the shaft was susceptible to carbon monoxide attack (750 to 1110 F with optimum effect at 840 to 930 F), a material was sought with the same general composition as an aluminous firebrick but which was much lower in iron, and with such iron in a safe condition against the action of carbon monoxide. China clay, a constituent of decomposed granite — an igneous rock — appeared to be the answer. This material, fired at 2730 F, is known as molochite, and Ball clay for bonding came from the same source. China clay bricks should have a bulk

density of 130 lb cu ft. The iron content does not exceed 1 per cent expressed as Fe_2O_3 and this must be finely disseminated.

The development of this practice continues, and although one could show better figures this present illustration is typical of the material actually in use. The general properties of the bricks are now more closely controlled and improved; the latest development being bonding the molochite with china clay itself, and dry pressing. Naturally, the safeguarding of the process against contamination with tramp iron during manufacture is most important and attention in this direction is still further reducing the iron content of the resulting brick.

To sum up, one furnace, operating on lean ores, has already made 60 per cent more iron on this type of stack as opposed to firebrick and it is hoped to reach 100 per cent. Cost is three times that of good firebrick compared with four times in the case of carbon. A lining of this type, installed in one of the 20 ft furnaces at Corby two years ago, continues in operation.

The orthodox basic bessemer or Thomas process of steelmaking used in Europe — and by that I mean the conventional air blowing process generally used requires a pig iron of not less than 1.6 per cent phosphorous. Iron for this purpose, however, usually contains betwen 1.8 per cent and 2.1 per cent phosphorus. It is not possible to generalize on the metallurgical acceptability in the open hearth of either hot metal or cold cast pig of a phosphorus content exceeding your standard 0.4 per cent, as such a survey inevitably centers on the allocation of uprising steelworks and purchased scrap. I shall refer to this balance below, when quoting examples of open hearth practice in Europe.

Manganese is also in some locations a constituent of major importance in pig iron. For example, in central Sweden and in Austria, manganese contents between 2 and 3 per cent are a natural consequence of local ores. This iron is an excellent raw material for open hearth steelmaking, since its high manganese content is a protection against the action of oxygen during decarburizing and refining; so much so that iron over a wide range of manganese contents from 2 to 6 per cent is deliberately produced in Western Germany, France and Belgium from especially imported ores.

In Thomas pig irons, the silicon content has a practical as well as a metallurgical importance. When the content exceeds 0.5 per cent Si there is danger of an excessive loss of Fe in the relatively greater weight of slag and also by ejections from the vessel. A silicon content of 0.3 to 0.4 per cent is therefore regarded as the best, and this is regularly in continental European practice, where for blast furnace slags of lime/silica = 1.2 to 1.4 the alumina content is about 13 per cent and the magnesia about 4 to 5 per cent. In English (Northamptonshire) Thomas irons rather higher silicons than the ideal are the inevitable result of a local burden from which the slag contains 22 to 23 per cent alumina.

Among the development items which at present are still in the research stage, we could note (a) steam injection in the hot blast, (b) lime injection through the tuyeres, (c) the measurement by radioactive tracers of gas transit times in the furnace, (d) the high-speed stereoscopic photography of conditions in front of the tuyeres, (e) the delineation of stockline contours by the "fishing-rod" technique, and (f) the analysis and assessment of furnace performance by mathematical statistical methods.

Developments are actively proceeding in Europe on ironmaking in low shaft furnaces, as they are called.

At Oberhausen, the Humboldt process has been operated for some years on a charge of ore and coal briquettes; the latest furnace was commissioned in 1949 and there is, more recently, the OEEC international project centered at Liege.

The essential features of the Liege project are the production of Thomas pig iron using, on the one hand, low grade fuels like semi-cokes, lignites, etc., and, on the other, minette ore fines from Lorraine or Luxemburg, flue dust, pyrites residues, etc. The furnace has an oval hearth, the major and minor axes of which are 9 ft 9 in. and 4 ft respectively. The burden throughout will be up to 400 tons per day and the residence time of the burden in the furnace is expected to be not more than two hours. Provision has been made for oxygen enrichment of the blast up to 50 per cent, for which about 50 tons of oxygen will be required daily.

The fundamental reason behind this development is the desire to produce iron from ores and fuels which are unsuitable, by size and quality, for use in the conventional blast furnace, at any rate without expensive preparation. The coke rate in this practice is high — 2000 to 3000 lb per ton of iron. The economics of this process depend in great measure on the full utilization of the relatively rich gas made.

Direct processes — Interest in the developments of an economic process covering the direct reduction of iron ores to melting stock continues.

The Krupp-Renn process started with the object of providing melting stock for refining in steelmaking plants, but it has shown more promise, in Czechoslovakia and Germany, as a method of concentrating lean and highly siliceous ores. The object is to obtain small nodules of part-melted iron, together with a viscous slag, and herein have lain the main operating difficulties. Refractory wear has been high, and the problem of obtaining a clean separation of iron and slag has not yet been entirely solved. Even after magnetic separation, the product has so far only been usable, because of its high sulphur content, for resmelting in the blast furnace.

Only two processes for the production of sponge iron for melting stock have so far been able to meet the economic conditions of industrial operation. Both were invented and are now increasingly in operation in Sweden; they are the Hoganas and Wiberg processes. In Sweden, where some 50,000 tons are being produced annually, sponge iron will find its main use as a substitute for charcoal pig iron in the open hearth process, but it will also be used in place of scrap for high quality steels in general on account of its high purity.

The Hoganas process has the distinct advantages of setting no lower limit to ore particle size and, therefore, no preliminary sintering is needed. Sulphur contamination is avoided and the product, in cakes, is porous and strong; it has mainly been used in furnaces producing high quality steels and, more recently, for the manufacture of iron powder.

The essential feature of the Wiberg process is that

in a continuous vertical shaft furnace the ore is treated and reduced in the four stages — preheating and sulphur removal (up to 1600 F); pre-reduction, at 1600 F (Fe_2O_3 to FeO); reduction at 1850 F (FeO to Fe) and cooling.

The descending charge of lump or sintered ore is about 90 per cent reduced and produces sponge containing nearly 80 per cent Fe with 0.7 per cent C and very low sulphur and phosphorus contents.

The reducing zone of the furnace is in closed circuit with a hot coke carburetor. The reducing gases (CO 75 per cent; H_2 21 per cent; CO_2 2 per cent) are introduced at the foot of the reduction zone and mainly exhausted from the top where their composition is then CO 59 per cent; H_2 11 per cent; CO_2 24 per cent. The exhausted gases enter the carburetor, where they are regenerated by passing over hot coke. The regenerated gases leave the unit at 1900 F and are passed through a limestone bed for sulphur removal before re-entering the furnace. The coke consumed in regeneration is about 400 lb per net ton sponge and the power requirement for heating the coke is about 800 kwhr per net ton. The relatively small portion of the gases at the top of the reducing zone which are allowed to ascend into the pre-reduction zone meet combustion air in this part of the furnace, and the products of combustion are used to preheat the descending ore charge. These spent gases exhaust at low temperature.

The Wiberg process is based essentially on sound thermodynamic and metallurgical principles and it is important to note how far these are being applied.

STEELMAKING

We have earlier noted that most of the ores mined in Europe are phosphoric, and this is significant in considering how blast furnace iron is allocated between the open hearth and basic bessemer processes of steelmaking. In France, Belgium and the Saar, in 1952, the greater proportion of the iron made was refined in basic bessemer converters, and in Luxemburg the basic bessemer process was used to the exclusion of the open hearth. In Germany, also, the proportion of the total iron made which was refined by the open hearth process was small in relation to that of the bessemer. In the United Kingdom, as in Italy, Sweden and Spain, most of the iron produced was for the open hearth process.

Considering our steelmaking operations and practice, the important part played in Europe by the basic bessemer, or, as it is more generally called, the Thomas steel process, will be evident to you, and, undoubtedly, the significant factor to report to this meeting is the rapid technical development of that process which is now taking place.

On open hearth practice, it is unnecessary in this general review to deal with our practice in furnace design, all-basic construction, or the actual detail of process control, as our development and practice in these respects are already well known. At the moment, however, it is sufficient to say that while the European furnace and plant units are, on average, smaller than your own, there is little difference between us in plant layout generally, or in the other features mentioned, at any rate in our more modern units.

When, however, the basis of European open hearth manufacture is considered, there are features of practice worth bringing forward to you for their dissimilarity with your own.

The distinctive features on the Continent are that the maximum degree of iron pre-refining is carried out prior to the open hearth, and that such iron as is used direct in the open hearth furnace is a small percentage of the total charge. Further, this iron is generally produced (from imported ores) in a composition specifically designed to meet the metallurgical requirements of this specialized practice. This particular iron — "Fonte d' affinage" in France and Belgium and "Stahleisen" in Germany — is used extensively and, typically, is high in carbon as well as in manganese. It is usually a 3 to 4 per cent manganese iron with sulphur 0.04 per cent maximum and phosphorus under 0.4 per cent, but in some cases the phosphorus content may be higher, depending on the balance of local and imported ores used. The silicon content at 1 per cent maximum is graded in line with the proportion of iron used and to balance the slag requirement. Often this material may be 15 to 25 per cent of the open hearth charge, depending on its composition, but, in many instances, it is as low as 10 per cent, and this constitutes the entire raw iron charge to the open hearth. The balance of the charge is uprising process scrap from both open hearth and bessemer ingot production at those plants where open hearth furnaces are reserved virtually as scrap melters; it may also be blown metal from the bessemer plant or a mixture of both blown metal and scrap. By either variation, the metallurgical load is light, control of the process is facilitated, and the output rate is high. The thermal input required can be taken as 4 to 5,000,000 Btu per ton. There are, admittedly, instances, particularly at cold metal plants, where a portion of direct basic iron is used in the charge, but the practice mentioned is more typical of Continental operation.

It will be seen, therefore, that on the Continent, with the ore compositions available, open hearth practice is largely restricted to the use either of liquid metal pre-refined by bessemerizing or to a scrap background augmented by a small percentage addition of iron made to a special composition from imported ores.

The position is somewhat different in the United Kingdom, where, faced postwar with much the same ore position as on the Continent, the main method of steel manufacture is still the open hearth process, and basic bessemer contributes but a small proportion of the ingot steel produced.

Without the background source of bessemer-arising scrap, and in face of an expanding steel demand, it is understandable, that, in this case, the proportion of iron used in the open hearth charge has increased. It follows, therefore, that the metallurgical load on British open hearths is generally high by your own or by Continental standards. For example, the phosphorus content of the iron used is over the range of 0.4 to 1.6 per cent and, on the average, may be taken as around 1 per cent. The feature of technical interest worth noting in this situation is the increasing effort directed towards efficient means of pre-refining iron before the open hearth. Essentially, this covers methods of desiliconizing and dephosphorizing. These are conceptions aimed at the more effective reduction of silicon in

active mixer-furnaces, or in the ladle, by air or oxygen blowing. Incidentally, in this connection, it is worth noting that at least at two locations on the Continent — in France and in Germany — where basic iron is used directly in the open hearth, the iron is effectively reduced to 0.2 per cent silicon by oxygen lance treatment in the transfer ladles. The pre-refining of iron by bessemer blowing is also under consideration in the United Kingdom, and converter units have already been installed for this purpose at one location.

Basic bessemer process, orthodox practice and new developments — Turning now in more detail to the side of our steel process operations probably of most interest to you in view of its dissimilarity to your own — the basic bessemer process — it is essential that we should look first of all at the well-established practice of that process, that is, conventional air blowing.

The blowing time for a 25-ton converter, and measured as the actual time under blast, varies from 10 to 14 minutes for the foreblow, that is, to the flame drop and covering the period of silicon, manganese and carbon removal, with a corresponding afterblow of three to four minutes for the phosphorus removal.

A minimum phosphorus content of 1.6 per cent is necessary in the iron used in this air-blown process. At most locations the naturally arising content is 1.8 per cent and it is customary to bring this up to 2.0 per cent by the addition of phosphoric slag roughings to the blast furnace burden.

This process has produced many millions of tons of steel equal in chemical composition to best open hearth qualities with one exception, namely that bessemer steel has the higher nitrogen content. The process can be accurately controlled by the experienced operator to finish with the required phosphorus in the steel, generally to some maximum value within the range 0.02 to 0.06 per cent P, according to the specification.

It is not surprising, therefore, that in all European countries producing basic bessemer steel, development work has been directed, during the past 10 or 15 years, to finding economic means of producing low-nitrogen steels straight from the converter and according to requirements. There is, as a result of this work, broad agreement that the achievement of a low nitrogen content depends chiefly on the following factors:

1. Low partial pressure of nitrogen in the blast
2. Low blast pressure but with the same, or an increased rate of the blast supply.
3. Short time of contact between blast and metal.
4. Low finishing temperature consistent with good teeming behavior.

By controlling plant operation in accordance with the above principles, that is, a shallow bath of metal, a wide nose opening in the converter to minimize back pressure, the use of ore or scale (instead of scrap) for cooling, and the close control of the finishing temperature, it has been possible to reduce the nitrogen content from the normal range of 0.012/0.020 per cent to an average of 0.008 per cent. The Corby L.N.P. process and the Hanborn H.P.N. process are typical of modifications to established European practice which have been made over the last 10 years to give better physical properties from basic bessemer steel.

It will be noted, however, that while these modified

TABLE I

Data Relating to Oxygen Applications to Conventional Bessemerizing

		Enriched Air	Steam/oxygen
Operation			
Approximate number of blows made to April 1953		5000	1000
Blast			
Blast Composition		30% total oxygen throughout blow	40% steam/60% oxygen throughout blow
When used		12,400	5,300
Mixed blast:–	flow, cfm	—	22.5
	pressure, psi	—	355
	temperature, F	1550	3350
Oxygen (95 per cent pure):	flow, cfm	50	50
	pressure, psi	185	185
	temperature, F	—	154
Steam:–	flow, lb/min	—	150
	pressure, psi	—	480
	temperature, F	10,850	—
Air:	flow, cfm		
Blowing time, min		8	8
Consumptions (weight of iron charged to converter = 31,400 lb)			
Oxygen:	per blow, cu ft	12,400	26,800
	per ton iron, cu ft	790	1710
Oxygen cost:	per ton iron, $	0.54	1.19
Steam:–	per blow, lb	—	1230
	per ton iron, lb	—	78
Extra scrap		280 lb/thousand cu ft oxygen	scrap per ton iron only half that with normal air blow
Steel nitrogen contents–			
With scrap:–	average per cent	0.007	0.0020
	maximum per cent	0.010	0.0025

(Double slag (soda) reduces phosphorus to 0.025% P max. when required)

practices produced a steel of nitrogen content approaching that of the basic open hearth, it still did not equal open hearth in this respect, and the disadvantage of basic bessemer steel in certain applications definitely remained.

Several European steelworks are now using, throughout the blow, a blast enriched to 30 per cent oxygen which gives, so far as nitrogen in the finished steel is concerned, results comparable with the carefully controlled scale — or ore — blowing processes referred to above. What is important is that the enriched oxygen blast shortens the blowing time by 30 to 40 per cent, and so increases the rate of output by 15 to 20 per cent. The increased temperature which results from the reduced volume of nitrogen blown enables a greater proportion of scrap to be carried. The economic advantage of the basic bessemer process is fully retained.

This particular application of oxygen, apart from the economic attraction mentioned, has made available a range of basic bessemer steels of what might be termed "medium" nitrogen content.

This is undoubtedly a considerable advance but it is not the end point of this development. A special method of the application of oxygen has been developed in Belgium and Germany with the object of reducing still further the nitrogen content of the finished steel. This is blowing throughout the blow, or for the major part of it, with a mixture of 60 per cent oxygen of 95 per cent purity and 40 per cent steam. (An alternative method utilizing carbon dioxide in place of steam has been tried experimentally but I have no production data relating to this possible variation.) This oxygen/steam mixture is approximately thermally equivalent to air. The steel thus produced has a maximum nitrogen content of 0.0025 per cent and, on cold working and aging, hardens even less than normal open hearth qualities, since these generally have double the nitrogen content. Oxygen contents in the steel are still of the same order as an open hearth steel, and hydrogen has so far given no trouble.

The oxygen consumption, using this steam/oxygen method of blowing, is approximately 1500/2000 cu ft per ton of steel produced compared with under 1000 cu ft per ton with oxygen enriched air blowing. Less scrap can be carried in steam/oxygen blowing, so that the steel thus produced is slightly more expensive than ordinary air-blown basic bessemer steel, but, in general, the cost of steel production by this process is still under that of the open hearth.

The ability to control the nitrogen content to any required figure, employing either the enriched oxygen blast or the steam/oxygen practice, gives to the basic bessemer process a new flexibility, not possessed by other refining operations. It is now possible, by these methods, to produce steels by the basic bessemer process which are the equal in chemical and physical properties, and in some respects superior, to equivalent grades made by the open hearth process.

Table I summarizes in convenient form the essential data relating to these oxygen applications to conventional bessemerizing. It will be noted that these data stem from a full production basis.

Careful sampling of the blown metal has indicated that the hydrogen content of the steam/oxygen steel is of the same order as normal (i.e., up to about 5 cc H_2/100gm).

Although this particular plant is the first in Europe to use steam/oxygen in continuous full-scale production, and therefore the results quoted above apply specifically to this plant, the values given for enriched air are confirmed by similar results at several Continental plants.

An alternative method to the steam/oxygen process has been developed in Austria and has been operating on a production scale since January of this year.

The process is designed to refine iron rapidly and to produce a similar quality of low-nitrogen steel. Thirty-ton blowing vessels are used, and these might be regarded as solid-bottom converters. Oxygen is supplied through high-pressure vertical nozzles arranged at a fixed distance above the surface of the bath, and is injected at supersonic speeds. The blowing time and the time from tap to tap, considered ton for ton, appears similar to that of conventional bessemerizing.

The volume of oxygen used is similar to that in the steam/oxygen process at an average of 1800 cu ft per ton of metal blown. Ten to fifteen per cent cold scrap has been added to the vessel, and attempts are being made to increase this proportion. The composition of iron used, at 2 per cent manganese and 0.2 per cent phosphorus, would normally be unsuitable for bessemerizing by established practice, and oxygen enrichment of the blast would in any case be necessary.

"SOME ECONOMIC ASPECTS OF THE EUROPEAN STEEL INDUSTRY"

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▲ THE European steel industry can hardly be considered a homogeneous entity, and I will, therefore, begin by outlining the areas within which I shall develop and consider certain economic aspects.

For convenience, and because developments since the war have brought some parts of the European steel industry together so that a certain amount of comparable information was available, I propose to divide the European industry into three parts: namely, that which is east of the Iron Curtain; that which is west of the Curtain and is situated in countries which enjoyed the benefit of Marshall Aid; and the marginal remainder, which includes Finland, Yugoslavia and Spain. The last group has a production of about 1,700,000 short tons, and the first, or Eastern Group, has a production of about 12,000,000 tons, not including the USSR whose production is 38,000,000 tons. (Throughout this paper, all tonnages are net tons of 2000 lb, except where otherwise indicated.)

The middle group consists of 19 countries, which include the major producing countries of Europe, i.e., the six members of the Schuman Treaty and the United

Kingdom. This group, which I shall refer to as the OEEC countries (The Organization for European Economic Cooperation set up to administer the Marshall Plan), produced 68,200,000 tons of steel in 1952. There was a net export from this group in 1952 of about 8,000,000 tons. This left an apparent consumption of some 60,000,000 tons in the home markets, compared with 51,800,000 tons in 1951 and 46,300,000 tons in 1950.

These figures reveal a very considerable growth in consumption. Today, production, which has continued to grow, and which reached a rate of over 71,000,000 tons per annum in the first quarter and might reach over 73,000,000 tons this year, appears to be overhauling demand.

THE RISE OF FLAT PRODUCTS

The pattern of industry is not only of importance in any attempt to assess total steel consumption, but also has a marked effect on the product-mix required from the steel industry. One of the more notable trends over the last 30 years has been the growth in the consumption of flat products, particularly thin flat products.

In actual production the United States has expanded by 140 per cent in thin flats since 1929, whereas Europe has only expanded by 50 per cent. The ECE study from which these figures are drawn, by combining figures from many of the principal producing countries, anticipates a further potential expansion in Europe from 1951 to 1956 of 64 per cent in thin flats and 28 per cent in heavy flats (over 5mm). In thin flats this would be a far greater rate than is indicated by the most optimistic view, namely, that of the OEEC of total consumption of steel, and indicates a belief in the further speeding up of the change-over in Europe to the use of flat products after the American fashion. Moreover, it indicates an optimistic view in regard to the continued rise in European standards of living. The study takes into account the anticipated output of 11 continuous or semicontinuous wide strip mills now either in operation or under construction in Europe. There has been a great deal of optimism and faith in going ahead with these mills, although, in most of the countries concerned, conditions are entirely different to those which existed when the revolution took place in the United States, particularly as regards taxation and plant costs.

STEEL CAPACITY

In this matter of capacity, I am going to explain why we do not measure and publish capacity figures in Europe as you do in America. Your Institute publishes regular statistics; why isn't this done by European countries? Quite honestly, I helped to oppose the collection of such figures internationally by the Geneva Committee. The European pattern of production is so irregular, the burdens of the furnaces so diverse, that to provide figures of "theoretical capacity" would be meaningless for the purposes of comparison for which they are required. It has recently been tried by the European Coal and Steel Community, but the results were utterly unrealistic and bore no relation to "possible production," which is a rather different concept. We have used this concept at the Paris Committee in our studies of the raw material situation. It has proved useful and has enabled us to put together reasonably comparable "maximum production" figures.

TABLE I

CRUDE STEEL PRODUCTION

(000's short tons)

	Actual 1936-38	Actual 1952	Estimated maximum 1956
W. Germany	17,840	17,426	21,200
France	7,662	11,981	19,800
Saar	2,650	3,112	
Belgium	3,441	5,621	7,200
Luxemburg	2,179	3,310	4,000
Italy	2,365	3,822	3,700
Netherlands	48	755	1,000
ECSC total	36,185	46,027	56,900
United Kingdom	13,131	18,391	21,200
Sweden	1,139	1,862	2,300
Austria	638	1,166	1,400
Other OEEC	120	778	800
OEEC total	51,213	68,224	82,600
Other W. European	661	1,657	1,900
Total W. European	51,874	69,881	84,500

Table I gives a fair picture of West European steel expansion plans and is based on maximum possible production, making due allowance for down time for maintenance and repairs and assuming a normal supply of raw materials to be available.

THE MATERIAL SUPPLY PROBLEM

The sum of the countries' "maximum production" targets is of the order of 85,000,000 tons for 1956 based on their intended development. In many cases, a good proportion of their development schemes are in hand. The fundamental problem is not one of steel capacity, but the material supplies. The program hinges on two main items, the supply of iron ore and the building of sufficient blast furnaces.

The steady expansion of steel production and the loss of the prewar imports of scrap from the United States has radically changed the character of the scrap supply to the European industry. The low level of steel production in Germany immediately after the war and the availability of war damage scrap gave the United Kingdom steel industry (the major prewar scrap importer) a large supply of imported scrap which provided a valuable breathing space in which to make the adjustment to the new conditions.

In 1951, consumption of materials in steelmaking in the OEEC countries, which account for 98 per cent of West European steel production, included 28,200,000 tons of scrap and 40,700,000 tons of pig iron. This was a pig iron/scrap ratio of 65/45 and contrasts with the anticipated pig iron/scrap ratio in 1956 of 70/39.

This change is being prepared for by a very extensive blast furnace program. The program involves the building or rebuilding of a large number of furnaces in the main steel-producing countries. Much has already been

done. For example, in France 38 furnaces were scheduled for rebuilding and 29 have already been completed. It is, however, in the United Kingdom that the largest change is to take place. The United Kingdom pig iron/scrap ratio in steelmaking is expected to change from 46/63 in 1950 to 57/49 by 1957.

Some six new furnaces came into production in recent months and a further 16 are in prospect during the next few years. This will increase pig iron production from 10,900,000 tons in 1951 to nearly 17,000,000 tons in the long term. These furnaces will be in line with the recommendations of the Anglo-American Productivity Team and some will be of 29-ft hearth diameter. While the furnace programs on the Continent do not include such large sizes, there is a general trend towards bigger furnaces, impeded perhaps by the small size of many of the producing units.

Pig iron output in these countries in 1951 was 47,700,000 tons. This will have to rise to 63,000,000 tons in 1956 in order to achieve the OEEC steel production target of 77,000,000 tons and the comparable foundry output. If the programs envisaged are carried through there will be no lack of capacity for pig iron making.

"USE OF RARE-EARTH METALS AND COMPOUNDS IN STAINLESS STEEL MELTING"

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and
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▲ IN a previous publication we reported the pronounced effect of "misch-metal" additions on the hot-workability of austenitic stainless steels. The alloy content of the stainless steels investigated ranged from 4 to 70 per cent nickel, from 10 to 60 per cent of the elements chromium, molybdenum and tungsten, the maximum content of any one of the elements chromium, molybdenum and tungsten being 30 per cent, with or without other elements such as copper, manganese, silicon, cobalt, columbium, tantalum, titanium, etc. The analytical residual cerium and lanthanum content was correlated with the improvement in hot-workability (U.S. Patent 2,553,330). Here, and hereinafter, as in our previous article, lanthanum means all the rare-earth elements except cerium.

It was pointed out that the effect of misch-metal additions (hereinafter to be identified with the terms "cerium and lanthanum") on the hot-workability could range from a spectacular effect in alloys of high chromium and nickel contents with or without other elements like copper and molybdenum, to only slight effects in such standard alloys as AISI Types 316, 308 and 309. Type 310 is an alloy that is in the boundary zone of this effect, in that if the metal is properly made in the arc furnace, it can be inherently ductile, and the effect of misch-metal will be small, but worthwhile, on yields of prepared billets, etc. On the other hand, Type 310 can be inherently nonductile when made under certain furnace conditions, and in these cases, the effect of misch-metal additions can be large and represent the difference between a usable or a scrap heat.

Figure 1 shows the range of cerium and lanthanum contents needed to obtain hot-workable metal by overcoming hot-shortness in alloys containing chromium,

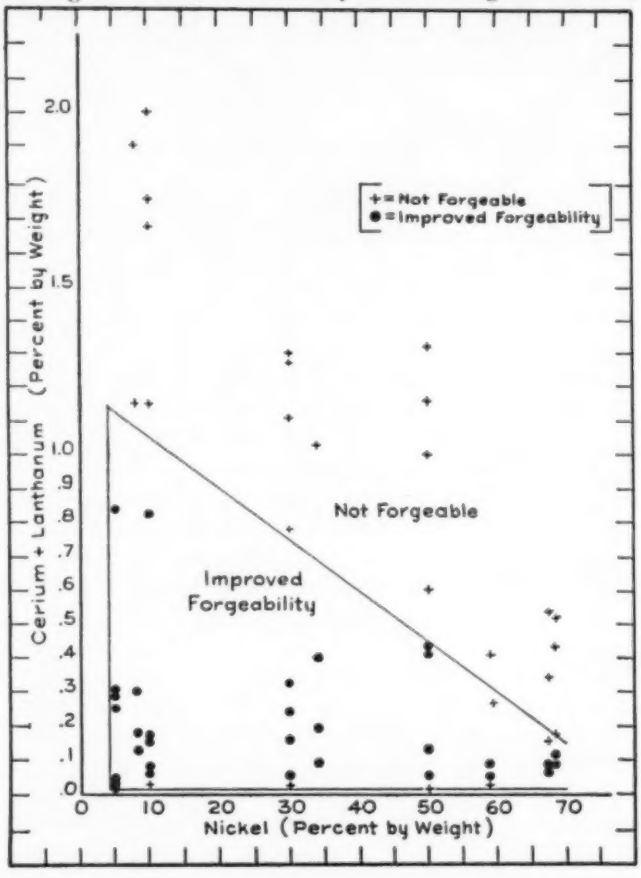

Figure 1 — Effect of nickel content on maximum and minimum residual amounts of cerium and lanthanum to improve workability in austenitic stainless alloys containing chromium, molybdenum, nickel, etc.

molybdenum, tungsten, nickel, copper, etc. Figure 1 shows that as the nickel content increases, the maximum amount of cerium and lanthanum which can be used to keep the alloy hot-workable decreases, while the minimum amount of these two elements needed to obtain hot-workability is about 0.02 per cent.

It should be remarked now that most of the data of Figure 1 were obtained on high-frequency melted steels, and were primarily directed toward imparting hot-workability to high-alloy stainless steels. We knew that some difference existed between Ajax and electric arc furnace melting in the specific amounts of cerium and lanthanum needed to obtain these improvements in hot-workability. A few low alloy grades of austenitic stainless steels made in the arc furnace showed that smaller misch-metal additions could be used to smooth out the hot-working as compared to the same grades melted in the high-frequency furnace.

To summarize:

1. Misch-metal additions to high-alloyed austenitic stainless steels, which are inherently hot-short, can transform them into ductile alloys. Our experience has been that these types of alloys require the cerium and lanthanum contents to be 0.02 per cent minimum.
2. Misch-metal additions to low-alloy austenitic stainless steels represented by Types 316, 308, 310, etc., where the metal is inherently ductile, can lead to improvements in hot-workability as judged by improvement in prepared billet or slab yields.
3. The larger misch-metal additions required for converting the inherently hot-short alloys into hot-workable alloys, and the smaller misch-metal additions which can be used to gain an improvement in hot-workability in low alloy austenitic stainless grades like Types 316, 308, 310, etc., suggest that cerium and lanthanum when added to the molten alloys counteract the hot-shortness, and improve the fluidity and the ingot structure simultaneously.

MIXTURES OF RARE-EARTH OXIDES

Several products have recently appeared on the market in the form of mixtures of the rare-earth oxides together with borides, nitrates, and silicon, which are supposed to reduce the rare-earth oxides at the molten steel temperatures. A typical analysis of such a purchased mixture is as follows:

50 parts rare-earth oxides which are 94 per cent pure oxide,
6 parts calcium boride (CaB_6),
4 parts sodium nitrate ($NaNO_3$).

The mixtures are used as ladle additions to stainless steels for the purpose of improving the hot-workability, as represented by improved prepared billet or slab yields. Ladle additions of the order of one to four pounds per ton are used in the case of inherently ductile steels such as Types 316, 308, 310, etc.

To summarize:

1. Rare-earth oxide mixtures can lead to improvements in the hot-workability of inherently ductile austenitic stainless steels, such as Types 308, 316, 310, etc., as evidenced by higher prepared billet yields, at a significant reduction in cost, when compared with misch-metal additions.
2. Rare-earth oxide mixtures do *not* lead to improvements in the hot-workability of essentially hot-short, or difficult to hot-work grades of austenitic stainless steels, where residual cerium and lanthanum contents of 0.02 to 0.25 per cent are generally beneficial.
3. The recovery of cerium and lanthanum from the commercial rare-earth oxide mixtures is small, if not altogether absent.

Cerium fluoride additions to the ladle or the molds, or in some cases, at both places, have been found to improve the ingot surface and the hot-workability of austenitic stainless steels which contain titanium as an alloying element. These additions are of the order of two to three pounds per ton to the ladle and/or two ounces per 1000 pounds of metal in the mold. As an example of the use of cerium fluoride in the molds, a two ounce addition per 1000 pound ingot enabled an average increase in prepared billet yields of 2.6 per cent per heat for 30 heats of Type 321 made in this manner, as compared to the previous 30 heats made with our best melting practice for this analysis on 12-ton electric arc furnace heats. The improvement in cleanliness of this grade of steel was equally as striking as the improvement in yields.

"ANALYSIS OF VARIABILITY IN ACCELERATED CORROSION TESTING CABINETS"

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▲ THIS paper presents the results to date of the work of the American Iron and Steel Institute Technical Committee on Protective Coatings of a study of the reproducibility obtainable in spray or humidity test cabinets.

The committee was primarily interested in developing a test for "slushing oils" for steel sheets, which could be used for evaluating the many oils on the market.

The questions to be answered were:

1. Are the exposure conditions within the cabinet uniform?
2. What is the variance associated with the cabinet?
3. How can we compare one cabinet with another?

This project was undertaken in December of 1949. One round-robin test has been completed. This test comprised five test cabinets, all different. From the data obtained on the first test, it was decided to change the oil to a more protective oil for the second round-robin. This second test is now in progress and present results indicate a confirmation of the conclusions from the first test, with some additional ideas for future work. The committee believes that real progress has been made towards resolving the chaos of conflicting results with the many types of test cabinets and that the data obtained to date justify their presentation to those working in the same field. This may be considered a progress report, since work is proceeding along the lines developed in the report. It should be emphasized that this work and the conclusions and recommendations derived therefrom apply to any testing cabinet whether used for testing oils, paints, metallic coatings, or metals.

We can now set down definite direction for the operation of any corrosion testing cabinet and its comparison with any other cabinet.

1. A standard oil, paint, protective coating, or material, to which all other materials can be compared, should be selected. This involves a standard panel or material, a standard method of preparation of the surface, a standard method of application of the coating, if a coating is under test, and a standard method of determination of failure.
2. For the determination of the uniformity of exposure conditions in the cabinet, the cabinet would be completely filled with replicates of the standard. Analyze the data obtained, by variance. If "hot

spots" are found, adjust or revamp the cabinet to remove them and repeat the run with replicates. Repeat this process until the exposure conditions are uniform within the cabinet.

3. In all future runs, use replicates of not less than four, randomly distributed. This random set of four should be constant for all runs, i.e., the four standard panels should occupy the same positions in all runs.
4. Analyze the data from each run by variance, determining whether the differences between the materials are significant or are due to chance.
5. Establish a Shewhart-type control chart for the standard in each cabinet so that it can be determined if the cabinet goes "out of control" and to establish a progressively more reliable estimate of error of the standard. This method is now under development.
6. Compare one cabinet with another by means of the standard and by the use of variance analysis. This method is also under development.

"ULTRASONIC TESTING OF A LARGE ENGINE CRANKSHAFT"

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▲ THE steel industry probably provides a greater reservoir of profit from preventive maintenance than any other major industry. For many years it suffered most horribly from a disastrous depression. Preventive maintenance was definitely down at the "oil can" level. Then suddenly a prewar defense boom, followed by war and postwar booms, accelerated the demand for steel so rapidly that much of the plant machinery was called upon to produce far beyond its real capacity. This in turn accelerated the breakdown rate. Until recently, repressive tax laws and depreciation regulations added tremendously to the difficulty of replacing old equipment. This series of developments has focused attention to a higher degree than ever before on preventive maintenance schemes and especially on the use of nondestructive testing devices. By the use of these various testing devices the maintenance man locates a weak spot or an incipient failure and can schedule repair or replacement in an efficient manner. Without these devices the unknown defect increases in size, the part finally fails, causing damage to the machine, lost production, excessive maintenance, additional labor expense and waste of supervisory time. Used properly these devices can help to direct preventive maintenance along a path that will not only transfer many millions of dollars from repair bills to the profit side of the ledger, but will also keep plants in the business of producing saleable products instead of undergoing the all-too-common "delay for repairs."

Outstanding among these devices is the ultrasonic tester which deserves a prominent place among the miracles of modern science. The ultraonic tester searches through 80 feet or more of steel and detects defects with uncanny accuracy and speed. By its use breakdowns can be foreseen and forestalled, schedules maintained, and repair costs minimized. In the few years it has been used in the industry its use has many times promoted more efficient operation by locating parts that are near failure and pointing the way to efficient scheduling of parts replacement.

At the Cleveland plant of the Republic Steel Corp., the most important single operating unit is the 44-in. blooming mill. It is driven by a 25,000-hp steam engine which went into operation in 1916. During a regularly scheduled Sunday shutdown, the maintenance crew had been going through the usual mill inspection routine. The mill and its engine appeared to be in excellent condition. Bearing caps were removed, alignments checked, and wear measured. Nothing appeared to be amiss, even to the experienced eyes of the inspectors.

The ultrasonic test was the last step in the inspection, a final check. In this case all parts appeared to be sound except one of the crankshaft pins. In a hidden corner of a bearing shoulder were two extensive stress cracks. They were completely covered by the crankthrow, and thus definitely undetectable by any visual or other type of surface inspection. Of all of the inspection and test procedures available to the experienced and capable mill maintenance crew, the only one that had any chance of ferreting out these harbingers of disaster was the ultrasonic test.

The report of this discovery was received with mixed reactions. At one extreme was the desire to replace the shaft immediately. This desire was accentuated by the realization that cracks in the sections of the pins within the crankthrow could be even more dangerous than in the exposed section between the throws.

At the other extreme was an inclination to disregard the findings of this "glorified radio" as being too new and untried to be relied upon for so important a decision. In view of this conflict of opinion the engine was continued in operation. Ultrasonic tests were also continued. These tests revealed that the first cracks were growing and that new ones were appearing. Finally after five days the cracks became extensive enough to remove all opposition to the replacement of the shaft. The mill was shut down for two days while the crankshaft was removed and a spare one installed. The entire crankshaft was shipped to the manufacturer for replacement of the cracked crankpin.

Most significant in this experience is the fact that the engine did not fail in service. Lives were probably saved, production was maintained, and major damage was averted. In that one instance, in that one machine, in one steel plant, savings directly credited to ultrasonic testing were many, many times the price of the unit.

An important advantage to be acquired from the use of an ultrasonic test is that if the engineer or maintenance man knows that a crack is present, knowledge of its size sometimes permits him to continue to use the defective part and get the maximum possible production out of it. Ignorance of the depth of the crack would almost certainly impel removal of the part before the end of its useful life.

After removal from the engine, the old crankshaft was shipped to the manufacturer for replacement of the cracked parts. There, after disassembly, the existence of the cracks in the crankpin was confirmed, first by the manufacturer's own tester, then by magnetic powder, and finally in one instance by actual fracture of the pin.

"PROBLEMS IN THE DISPOSAL OF PHENOL WASTES IN COKE PLANTS"

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and

C. V. THOMPSON

Superintendent Coke Plant

Midland Works

Crucible Steel Co. of America

Midland, Pa.

▲ THE Ohio River Valley Water Sanitation Commission, or ORSANCO, embracing eight states in the Ohio River basin, is a coalition which is receiving full support and cooperation from the steel industry. Illinois, Indiana, Kentucky, New York, Ohio, Pennsylvania, Virginia and West Virginia are joined by a compact to control water pollution in the Ohio River district. A large segment of the steel industry is operating in this district. The commission is assisted by advisory committees representing all affected interests in stream purity control. The Steel Industry Action Committee, comprising representatives of most of the steel companies in the district, is most active in this work. In broad terms, the commission's responsibility, imposed upon it by the compact under which it was created, is to place and maintain the waters of the Ohio River basin in a condition so that they are:

1. Available for safe and satisfactory use as public and industrial water supplies after reasonable treatment.
2. Suitable for recreational usage.
3. Capable of maintaining fish and other aquatic life.
4. Free from unsightly or malodorous nuisance due to floating solids or sludge deposits.
5. Adaptable to such other uses as may be legitimate.

The steel industry is a contributor to the pollution of streams and surface waters. Its contribution in addition to the sanitary wastes produced within the plants themselves, consists principally of wastes carrying spent acid pickling liquor, suspended solids such as roll scale and blast furnace flue dust, oils and greases, and phenolic wastes from chemical recovery coke plant operations. The Steel Industry Action Committee of ORSANCO has subcommittees studying these various waste problems and conducting research leading to the solution of the problems involved in their control. The subcommittee on Coke Plant Wastes is doing a thorough job of uncovering facts concerning phenolic wastes and methods of reducing phenols from our plant sewers as part of their normal activity. Many steel companies, also, are engaged in experimentation, research, and pilot plant operation, looking toward development of improved methods for further reducing phenols.

The term "phenol," as used in this discussion, is a generic term, referring to a family of organic acids. They occur in important quantities as a resulting product from the destructive distillation of coal. They consist principally of phenol, cresol, and xylenol.

Phenols in strong concentration are toxic. However, in the concentrations encountered through dilution in streams, they are harmless to people and to fish. Water for domestic use should be free from unpleasant taste or odor from any source. Even though harmless physiologically, a bad taste or odor suggests to the general public that the water is not wholesome and may lead to the use of better tasting water that comes from questionable sources. Phenol has the unfortunate property, even in very minute concentrations, of imparting to potable water, especially after chlorination, an unpleasant taste and odor.

In addition to the popular misconception that phenol is the chief cause of tastes and odors in water, it is popularly believed that coking operations are the principal producers of phenolic wastes. This, of course, is a fallacy. Mr. A. R. Todd, of Wheeling, W. Va., stated that he could not tell when the steel strike started or stopped by the phenol content of the river. Chemical industries, oil refineries, and manufacturers of synthetic resins produce phenolic wastes in important quantities.

The Midland plant of the Crucible Steel Co. of America has what may be considered a typical coke plant operation. The occurrence of phenols in our sewers may be explained by a brief review of the coke operation itself, pointing out as we go along, the points where pollution with phenols may occur.

Conversion of coal to coke, with recovery of the various chemicals evolved in the process, is accomplished by heating the coal in the absence of air to a temperature above which the volatile matter is driven off, leaving a residue, or coke, which is principally carbon, plus the original ash of the coal and part of the sulphur. In the reduction of coal to coke, the complex structure of the coal volatiles are transformed by pyrolysis into various coal chemicals which, in a gaseous state, are collected through pipes from each oven in a large gas main running the length of the battery.

The tar contains a large proportion of the phenols produced in the ovens but presents no problem, as none of this phenol can reach the plant wastes. The liquor contains ammonia, both in solution and fixed as chloride, carbonate, sulphate and other salts of ammonia. It also carries other materials in solution, such as phenols, hydrogen sulphide, etc. It is called weak ammonia liquor. This liquor is treated in a still where the ammonia is recovered and reintroduced into the gas stream for subsequent recovery as ammonium sulphate. The effluent from this ammonia-still is called still waste and is the first, and perhaps the most prolific point where contamination of a waste with phenol may occur.

In the saturators, cooling water is sprayed directly into the gas and a large portion of the naphthalene is

removed. The naphthalene may be recovered in a tar absorber section of the cooler, where the cooling water is mingled with tar which absorbs the naphthalene, or it may be allowed to collect in a sump through which the outlet cooling water passes and where the naphthalene is skimmed off and recovered as such. The cooling water may contain an important amount of phenols and is the second principal potential source of contamination of the sewer.

The gas, on leaving the final cooler, passes to the benzol absorber, or scrubber. The vapors of benzol and its homologues which are present in the gas—toluol, xylol, heavy naphtha and the remaining naphthalene —are absorbed in the scrubbing oil. The "benzolized" oil is steam distilled in a continuous still and the vapors of the light oils and distillation steam are condensed. The condensed oils are called light oil, and with the condensed steam are passed through a decanter and are separated by gravity. The water from this decanter is a potential source of phenol pollution.

Generally speaking, any water which is condensed from the gas stream, or which has had contact with the gas or any condensate from the gas may be suspected as being contaminated with phenol and subject to treatment or impounding to abate pollution.

We have briefly gone over a flow sheet of a typical chemical recovery coke operation and identified the points where phenol contaminated effluents may reach the sewer if nothing is done to prevent it. We will now retrace our steps and discuss what can be done to reduce the phenol content in the wastes at these points.

The first point of contamination mentioned above was the waste discharge at the ammonia still. If any recovery of phenol is to be accomplished in this operation, treatment must be given before the weak liquor meets the milk of lime in the fixed still because the lime will serve to fix the phenol as calcium phenolate. Two methods are generally employed to accomplish this. They are the liquid extraction method and the vapor circulation method. The latter is the method employed at our plant at Midland.

In the liquid extraction method phenol is extracted from the weak ammonia liquor with a solvent before the liquor goes to the still. A substantial part of the phenol is then removed from the solvent by distillation or by extraction with strong caustic solution. Extraction with caustic is practiced universally in this country.

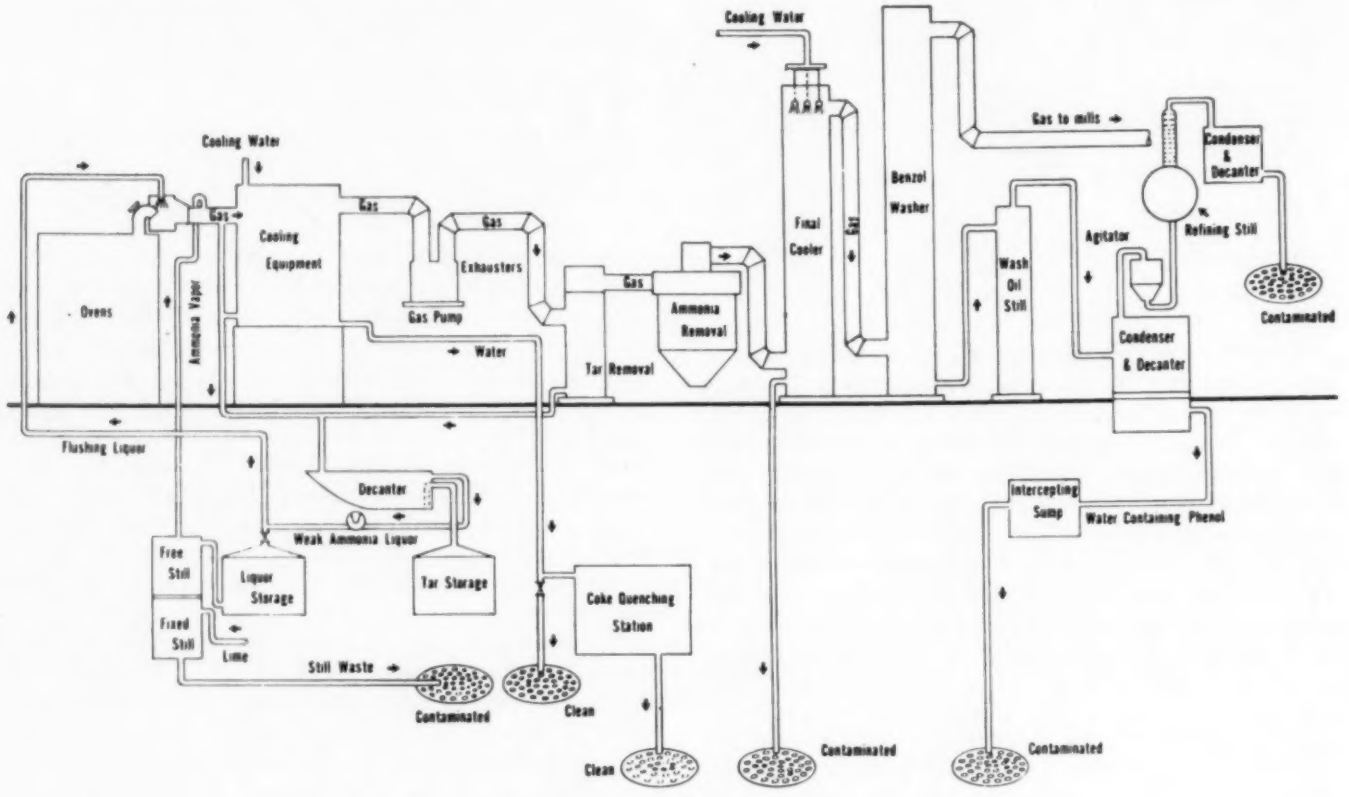

Figure 1 — Schematic shows phenol removal from coke plant wastes.

Benzol or light oil has been found to be a good solvent and is used in this country in all plants of this type. Benzol is insoluble in the liquor, it is not affected by the treatment with caustic, it has a low density and separates easily by gravity from the liquor and caustic solution, and it is produced in the coke plant and is readily available.

Vapor circulation extraction is the method in use at our Midland plant since 1950.

The dephenolizing tower consists of two columns, one set on top of the other for simplicity in operation. In the top section the ammonia liquor is stripped of phenols with hot vapor. In the bottom section the phenols are absorbed from the vapor by a dilute caustic soda solution. The vapor is recirculated by an electrically driven centrifugal blower. The vapor passes from the bottom section to the top section through a large riser. It is taken from the top of the top section through a downcomer to the blower and then enters the bottom of the tower.

Hot ammonia liquor from the bottom section of the free ammonia still is pumped by the feed pump into the top of the tower through spray nozzles. It passes down, over the wooden hurdle packing, to the bottom of the stripping section and from there returns to the lime leg of the ammonia still by gravity. The hot vapor, flowing up the column, strips most of the phenols from

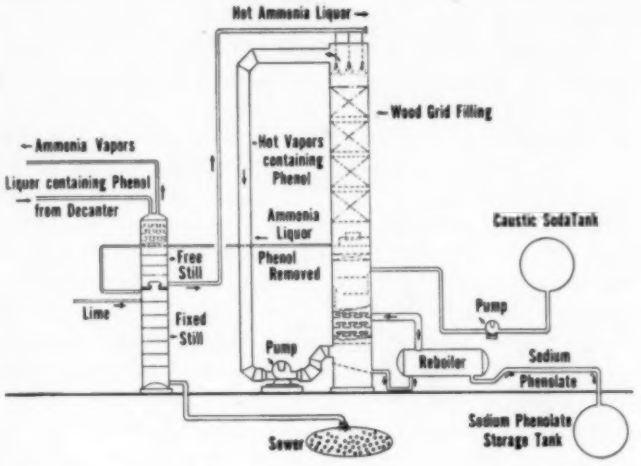

Figure 2 — Schematic shows principle of operation for phenol recovery vapor process.

the liquor. The vapor, carrying the phenols, is then pumped into the bottom of the absorber section.

Dilute caustic soda is pumped from the caustic soda dilution tank to the top of the absorber section. This section has five bubble cap trays. The caustic runs down over the trays absorbing the phenols from the vapor passing up through the column.

The mixture of caustic and sodium phenolate enters the reboiler from the bottom of the absorber section. There steam coils concentrate the solution by boiling off the water and furnishing steam from vapor. The concentrated phenolate flows from the reboiler to the storage tank.

In the ammonia still operation, 40 to 50 per cent of the phenols in the weak liquor is removed in the free still by the steam distillation. The dephenolizing tower, interposed between the free and fixed leg of the still, removes from 95 to 99 per cent of the remaining phenols. Uniformity of operation has been difficult to achieve, but our record in this respect has been steadily improving. During October, 1952, the phenol content in the still waste averaged 9 ppm with an input content in the weak liquor of 1640 ppm. The range in the waste was from a low of 3 ppm to a high of 25 ppm. In terms of pounds of phenol per day this represents 984 pounds going to the still and 7.2 pounds going to the coke plant sewer. We do not regularly determine the phenols to the tower, but allowing a 50 per cent efficiency for the free still, this record represents a tower efficiency of 98.57 per cent and an overall efficiency of 99.28 per cent. These percentages refer, of course, only to that portion of the whole problem which belongs to the ammonia still operation.

It should be recognized that methods presently in operation at some plants may, under careful control and supervision, accomplish a reduction of from 90 to 98 per cent of the phenols in ammonia still wastes. On the other hand, it must also be recognized that this high degree of removal has been accomplished only at relatively few very modern installations, and that most plants that have, in the past, installed either of the two types of dephenolizers are not able, in fact, to effect that high degree of reduction.

Operation of this tower cannot be justified economically. The tower represents a considerable outlay of capital. Our installation in 1950 cost about $225,000 and serves a plant carbonizing 3600 tons of coal per day. A recently estimated cost of a dephenolizer for a plant carbonizing 1350 tons per day is reported to be in excess of $460,000. The value of the recovered phenolate covers only a part of the capital and operating costs. Its justification is from the nuisance abatement angle only.

Some plants are disposing of still waste by using it to quench the hot coke in a closed system—one not having an outlet to the sewer. In this operation, the waste is added to the quenching water system and is evaporated. The main objection to this practice is that the calcium chloride in the waste tends to build up in the system, and creates a serious corrosion problem to equipment and surrounding steel structures. This system is accepted, however, by most regulatory bodies as satisfactory treatment.

It must be recognized that the preferred method for treatment of ammonia still waste must, to a large measure, depend on the circumstances of a particular location or installation. For instance, a plant using a fast coking rate, or processing a particular kind of coal which produces a lesser amount of phenol could find a dephenolizer more costly than quenching with still waste.

Complete agreement has been reached in the Steel Industry Action Committee on what may be considered minimum treatment of phenolic wastes. This agreement is expressed in the following recommendation to the Engineering Committee of ORSANCO and presented at the January meeting.

"The Steel Industry Action Committee recognizes the necessity for the further reduction of the phenols which presently reach surface waters. As previously outlined, we believe the Engineering Committee realizes the need for further studies by our subcommittee in the development of data essential for the ultimate adoption of stream objectives. Therefore, as an interim measure, we respectfully recommend adoption of the following methods of treatment for the byproduct coke plants of the steel industry:

1. For ammonia still wastes
   (a) Installation and operation of dephenolizers, or
   (b) The installation of a closed system of coke quenching.
2. For final cooler wastes
   (a) Installation and operation of closed systems.
3. For decanter wastes
   (a) Installation and operation of closed systems."

No action on this recommendation has been taken by the commission at this time.

"THE DESIGN AND CONSTRUCTION OF A CARBON LINED BLAST FURNACE"

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and

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▲ THE substantial increase in open hearth production, in conjunction with a decrease in scrap quality, has resulted in an urgent call for more iron from blast furnaces, and the ingenuity of the blast furnace operator has been severely tested to meet the demand. The immediacy of the problem and economic considerations make it desirable that the necessary increased production be obtained from existing facilities. One of the ways in which we have attempted to do this has been to increase the size of furnaces, where possible, as they came up for relining. The most attractive way this can be done is by reducing the thickness of linings without serious alterations to external dimensions.

To determine the feasibility of increasing our iron production capacity through the use of thinner refractory linings, a study was made of existing furnaces, taking into account our present knowledge of the dimensional relationships required for optimum furnace performance, and assuming that the minimum safe lining thickness at any point in the furnace would be the minimum found in no less than three present furnace linings. On this basis, the following conclusions were reached:

1. Worthwhile increases in capacity necessitate an increase in the hearth diameter. This means that the tuyere coolers must be moved back, with a corresponding thinning of the hearth wall.
2. With an increase in hearth diameter, good furnace performance requires that the ratio of working volume to hearth area be maintained or preferably increased. This means that all the lining above the tuyeres must be thinned at least as much as the hearth wall. Thus, in most cases plate coolers in the bosh would have to be withdrawn or eliminated.
3. In the majority of our furnaces, fireclay brick linings above the mantle could be reduced in thickness without exceeding safe limits, while linings below the mantle could not be reduced significantly without risk.

From the above, it was apparent that if we were to obtain any appreciable production gains in our present furnaces it was essential to employ a refractory which would permit the safe use of bosh and hearth wall linings which are thinner than the minimum we would desire for fireclay brick. Also, since bosh plates would require relocation in any event, it would be desirable to eliminate them as well as the resultant inevitable corrugated bosh surface, and explore the possibilities of a smooth working surface on the bosh. With a carbon refractory, it is possible to do both, and we believed that sufficient experience had been gained with carbon in these locations to justify such an installation. For example, carbon bosh linings are standard on several English and German furnaces today, and, in the case of the English furnaces, they are relatively thin, varying from 9 in. for 18 ft furnaces to 13½ or 18 in. for larger furnaces.

The adoption of a carbon lining for the hearth wall and bosh should provide the most positive means of obtaining increased production by changes in the lining in this region. However, to insure the maintenance of this production advantage throughout a campaign, the wear of the lining in the lower stack region must be at a minimum, and must remain uniform. This reflects the well-known fact that the effect on iron production of furnace enlargement above and below the mantle, resulting from normal wear, is far more likely to be adverse than beneficial, despite the resultant increase in working volume. This is because normal lining wear for 35 ft above the mantle is apt to be so uneven and localized as to reduce seriously the uniformity of material flow, with a detrimental effect on coke rate and general furnace performance. Accordingly, consideration was also given to the possibilities of carbon as a more permanent refractory for stack linings. The evidence from experience to date is limited, and certainly not uniformly encouraging. Information has been available primarily in England, and we are indebted to Messrs. Chesters, Elliot and Mackenzie of United Steel Companies, Ltd., for the following:

1. No. 6 furnace, Appleby-Frodingham. This furnace was lined completely with carbon brick in April, 1949, with tarred coke breeze between the brick and the shell in the stack. The upper part of the stack lining was lost within a year, and at the completion of a three-year campaign, the stack lining was practically gone except for a thin section extending approximately 15 ft upward from the mantle. Carbon in the present lining on this furnace is confined to the hearth wall and bosh, where it had survived the previous campaign in excellent condition.
2. No. 1 furnace, Appleby-Frodingham. This furnace was blown in, September, 1949, with an all carbon lining. Vermiculite packing was used behind the stack lining, and cigar-shaped coolers were employed. The upper stack lining is believed to have fallen in after 85 weeks, and after 104 weeks no carbon was found higher than 20 ft above the mantle. The stack was spray cooled and the furnace operated satisfactorily for the balance of the campaign in this fashion.
3. No. 5 furnace, Appleby-Frodingham. This furnace was lined completely with carbon brick in April, 1950. Vermiculite packing and cigar coolers were again used in the stack. In 1952 the furnace was down for hearth repairs and the stack lining was found to be badly cut. A firebrick facing was built in front of the worn lining with 6 in. of carbon ramming placed between. In the original lining, two Cobalt 60 pellets had been placed 6 and 12 in. in from the hot face, 10 ft below the stockline level. The pellet 6 in. from the hot face was lost

in two months. The other pellet was still in place at the time of the patch.

4. No. 4 furnace, Appleby-Frodingham. This furnace was lined in February, 1951, with carbon brick carried 30 ft above the mantle. Vermiculite packing and cigar coolers were used. At last reports this furnace was operating satisfactorily, with no evidence of lining failure.

This evidence strongly suggests that carbon has no place in the upper zones of the inwall lining, and also casts serious doubts as to whether it has any advantages in the lower zones just above the mantle. However, there appeared to be some worthwhile lessons in these experiences, which, coupled with recognized differences in operating conditions, carbon brick properties, carbon mortars, and details of construction appear to weigh in favor of a trial, particularly in the lower stack where the durability of carbon is greatest and that of fireclay brick is the poorest.

Thus it was decided to install a carbon lining in Gary No. 10 furnace, extending from the bottom of the stave coolers to 35 ft above the mantle. The height may be considered a calculated risk, balancing the desire to use carbon through the zone of greatest wear against the increasing probability of oxidation with increasing height.

In working out the details of construction, the major guiding principle, derived from our analysis of experiences to date, was that carbon should be restricted to water-cooled walls only, and to a thickness at which it could be effectively cooled, with no intervening fireclay brick, coke breeze or other insulation between the carbon and the shell. Plate coolers extending into the brickwork should be avoided if at all possible.

This principle meant the elimination of carbon in the central section of the hearth. This was considered of little importance, as carbon in this location contributes nothing to furnace capacity or the prevention of breakouts, and it has yet to be demonstrated that carbon is superior to hard burned super-duty brick in minimizing salamander formation.

Since only carbon wall construction was involved, it was decided to employ standard 9 and 13½ in. shapes which would possess superior physical properties and permit better contact with water-cooled shells. Petroleum coke brick were selected because of greater purity and strength, lower thermal conductivity, and more desirable oxidation characteristics than anthracite base carbon. The validity of some of these reasons admittedly may be questioned. Thus, the ash content may be of little or no significance, and the strength is less important in wall construction than in large beams in the hearth. The lower conductivity may be a real advantage in minimizing heat losses with this uninsulated, thin-walled construction, but does reduce the effective depth of water cooling. The cited oxidation advantage had reference to the observation that while weight loss by oxidation of petroleum coke brick may be slightly higher than anthracite base carbon, the oxidation is confined to the surface, while the anthracite carbon tends to oxidize in depth, producing the punky condition found in several used linings. This may be more a function of grain size than of the type of raw material used. If so, then it might be expected that anthracite carbon brick made of fine material instead of the coarse particles used in blocks would show more nearly the same oxidation behavior as the petroleum coke brick.

The foregoing is indicative of our lack of knowledge of what is desired in a carbon brick for blast furnace use. In previous installations, we and other users had more or less accepted the fact that carbon was carbon, and did little to ascertain the variability of the product and its significance on service behavior. Therefore, for this installation we requested the supplier to provide us with test data. Table I shows the average and the range of values determined on several lots of brick. It will be noted that the average values conform substantially to those requested, and that with but few exceptions, the variability is not excessive. The dimensional uniformity is not shown, but was approximately equivalent to fireclay brick linings.

Table II provides a comparison of No. 10 furnace before and after rebuilding. It will be noted that the hearth wall has been decreased 4½ in. in thickness from 27 to 22½ in. and the hearth diameter increased from 25 ft 6 in. to 26 ft 6 in. The inwall, which ranged in thickness from 48 to 43½ in., has been decreased to approximately 40½ in., providing additional working volume. The stack was also increased 6 ft 0 in. in height for the same purpose. The bosh thickness was changed from 27 to 22½ in. The furnace was changed from a 12 tuyere to a 16 tuyere furnace, and some additional stove capacity was installed.

The lower part of the hearth cooling staves is of conventional construction, but the tuyere jacket was modified so that in effect, the staves are extended up-

TABLE I

Properties of 9 and 13½ in. Series Petroleum Coke Brick

No. 10 Furnace, Gary Works

Property	Requested	Received		
		Average	Maximum	Minimum
Bulk Density, gms/cc	1.54 Min	1.56	1.60	1.52
Modulus of rupture, psi	2500 Min	2486	2772	2197
Crushing strength, psi	6000 Min	Long. 9623	13,625	7625
		Trans. 9273	10,225	7022
Permeability (D'Arcy's)	0.15 Max	Long.–0.125	0.547	0.044
		Trans.–0.045	0.075	0.028
Shrinkage, per cent—				
2900 F reheat	0.3 Max	0.185	0.45	0.08
Steam oxidation, per cent	3.0 Max	3.4	6.2	1.0
Ash content, per cent	1.0 Max	0.408	0.73	0.25
Coefficient thermal expansion	—	Long. 0.270	0.290	0.245
10^{-5} cm/cm/1 C		Trans.–0.474	0.488	0.463

No. 10 Furnace, Gary Works

TABLE II
Dimensions of Gary Blast Furnace No. 10 Before and After Rebuilding

	Old	New
Hearth diameter, ft-in.	25-6	26-6
Height of bosh, ft-in.	11-6	12-3
Height of stack, ft-in.	48-3/8	51-6 3/8
Total height, ft-in.	80-2 5/8	86-2 5/8
Inwall batter, in. per foot	1 1/16	1 1/8
Total volume, cu ft	40,039	46,858
Working volume, cu ft	34,264	40,774
Working volume/hearth area	67.1	73.6
Big bell diameter, ft-in.	15-4	15-0
Top diameter, ft-in.	20-0	20-6
Brick work, in.		
(a) Hearth	30	22 1/2
(b) Bosh	27	22 1/2
(c) Belt	48	40 1/2
(d) Inwall	43 1/2 to 36	—
Carbon section, in.	—	45 to 40 1/2
Fireclay brick section, in.	—	40 1/2 to 33

ward to approximately two feet above the centerline of the tuyeres. There is little chance for air infiltration through this solid construction when back-drafting or at any other time the furnace is off blast. This design permitted the elimination of the horizontal cooling plates normally inserted in the brickwork from the hearth staves up to the bosh, thus removing the possibility of moisture attack on carbon as a result of leaking plates, while at the same time providing sufficient cooling for the carbon hearth wall.

The carbon brickwork in the bosh was surrounded by a solid steel air-tight jacket. While this construction has been used on a number of furnaces in the past, a novel method of cooling was incorporated. In order to insure continuity of cooling at all times, which is not always possible with a shower spray, due to clogging or water failure, a series of channels was welded to the shell. A limited water failure would not leave the bosh immediately unprotected, as the overflow from these channels is at a higher level so that they will remain full of water for a reasonable period. An important advantage of this cooling system is the elimination of water messes often associated with shower cooling.

The carbon above the mantle is cooled by maintaining a sheet of water flowing down the shell. The shell cooling water is pumped to a reservoir-like half section of steel pipe which has been welded to the shell along its upper edge, the water spilling out between the bottom edge and the shell. The opening is adjustable to control the flow. Vertical fins were welded to the shell to reduce the effect of wind on the stack cooling water. Subsequently, a splash shield was provided over these fins for still better control. No water cooling is applied above the carbon brick.

The furnace was blown in on February 9, 1953, in the ordinary, routine manner of the plant.

The furnace came in hot and stayed that way for several days until it was decided to bring the silicon down into the desired range for standard open hearth iron.

March, the first complete month of operation, was very satisfactory, the coke rate being 1589 lb. The average daily tonnage of 1412 broke a record of long standing which had been made under unusually favorable conditions. The plant as a whole, however, showed improved performance during the same period. The furnace operated smoothly with almost a complete absence of hanging or slipping.

Temperature-wise, the furnace lining and shell has been fairly stable since March 16, 1953. Table III shows the average temperatures since that date at various points in the lining. At each level, the temperature given is the average of four quadrant readings, which have remained fairly uniform. The shell temperatures are taken after the water has been off long enough to stabilize temperatures, which is less than one hour. At the 24 ft level, the northwest quadrant couple indicated temperatures 50 F higher than the others at that level for a few days, but this difference later diminished. An interesting observation has been the emission of gas at the 19 ft level when holes are opened for taking temperatures. The temperature of this gas is 50 F higher than that of the backing material, indicating the effectiveness of the cooling.

The lining temperatures in Table III indicate a temperature drop of approximately 32 F per in. through the carbon brick in the stack lining, and check fairly well with preliminary calculations based on a thermal conductivity for petroleum coke brick of 42 Btu/hr/sq ft/degree F in. thickness. The data also indicate that the packing material is a good conductor of heat, and at least equivalent to the carbon brick. Actually, the supplier reported a conductivity for the packing of 480 Btu/hr/sq ft/degree F in. thickness, or about midway between the values for petroleum coke brick and graphite.

TABLE III
Lining Temperatures — Gary No. 10 Furnace

Location		Temperature F
Shell		
Bosh —	Bottom	192
	Middle	172
	Top	168
	Above channel	325
Stack —	Above mantle 2 ft	107
	Above mantle 24 ft	137
	Above mantle 34 ft	130
	Above mantle 48 ft	90
Inside Shell		
Above mantle 19 ft		
	Against packing	364
	Against carbon brick	426
	24 in. from hot face	1100
Above mantle 52 ft		
	1 in. through hot face	1300

It is interesting to note that the above temperature gradient corresponds closely to the 36 F per in. reported by Elliott in 1949 for the carbon stack lining on No. 6 furnace, Appleby-Frodingham. However, as the British carbon has only roughly half the conductivity of the carbon used in our furnace, this agreement presumably reflects the effect of a thinner lining and different conductivity of the packing material.

In taking this very large step in the use of carbon, we feel we have reason to be confident of the outcome of the lining below the mantle. Should this prove true, then the benefits thus to be derived from increased furnace capacity, smoother operation, and the elimination of bosh cooling plates, could outweigh higher initial refractory costs. In the use of carbon in the stack lining, we admittedly are on uncertain ground, but it is an area worthy of exploration, due to potential advantages.

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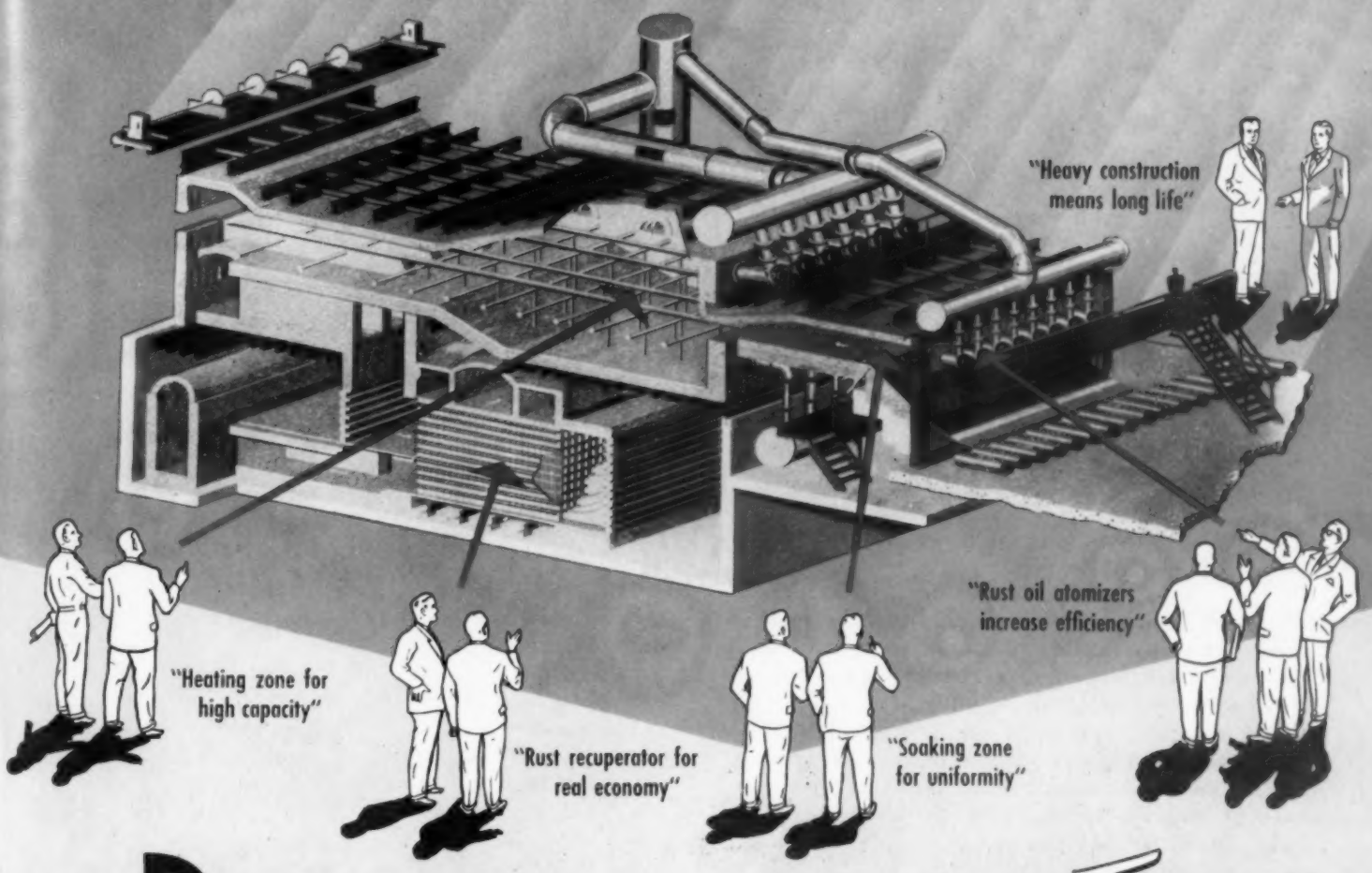
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REFINING IRON BY PURE OXYGEN

. . . . this report of a paper on "Refining of Iron by Means of Pure Oxygen Above the Bath," by H. Trenkler, Vereinigten Oesterreichischen Eisen-und Stahlwerke Aktiengesellschaft, Linz, Austria, was prepared by J. R. Miller, Ramseyer and Miller, New York, N. Y. . . . .

▲ H. TRENKLER'S paper is of major interest since his company has been operating the only full scale plant at Linz for the past six months. *(A similar unit is now in operation at Donawitz).* Mr. Trenkler briefly outlines the development of the process. After preliminary test work in a two-ton converter, the development activity was transferred to five- and fifteen-ton vessels in 1949, and ultimately to the present installation at Linz with thirty-ton vessels which were put into operation in the fall of 1952.

For an iron analysis of 3.7 to 4.4 per cent C; 1.6 to 3.0 per cent Mn; 0.2 to 1.0 per cent Si; 0.08 to 0.20 per cent P, and 0.08 per cent S max., the Linz operators found the open hearth method to be uneconomical. The regular Thomas process was also found unsatisfactory, mainly because of an inability to meet quality requirements. They therefore turned to the top blown oxygen practice, which was described as "something very new, with nothing in common with any previously used processes."

The new practice is described as "very simple in principle." Pure oxygen is blown above the bath through a water-cooled copper nozzle. The shape of the vessel is similar to that of an ordinary converter, except that there is no tuyere bottom. A 15¾ in. rammed bottom of dolomite magnesite (60 per cent MgO) has an average life of 120 heats, with dolomite consumption being less than 24 lb per net ton of steel.

Oxygen blast pressure is maintained from 60 to 170 psi. The nozzle is kept entirely out of the bath, the most desirable distance between the nozzle tip and the bath surface being determined during operation.

From 13 to 18 per cent of the total charge is scrap. After charging the scrap and iron, the converter is raised and the tuyere from which O_2 is being discharged is brought into place above the bath. Lime (100-140 lb per net ton of steel) is added by means of a chute. The drop of the flame indicates the completion of the conversion, since the dephosphorization and the decarburization takes place simultaneously.

The finished steel was reported to be satisfactorily low in N_2 and P; O_2 in the steel was said to be comparable with open hearth steels. No deoxidizing additions are made at Linz, even when producing extra mild steels. Iron content in the slag ranges between 10 to 15 per cent in 30-ton heats, and between 15 to 20 per cent in 15-ton heats.

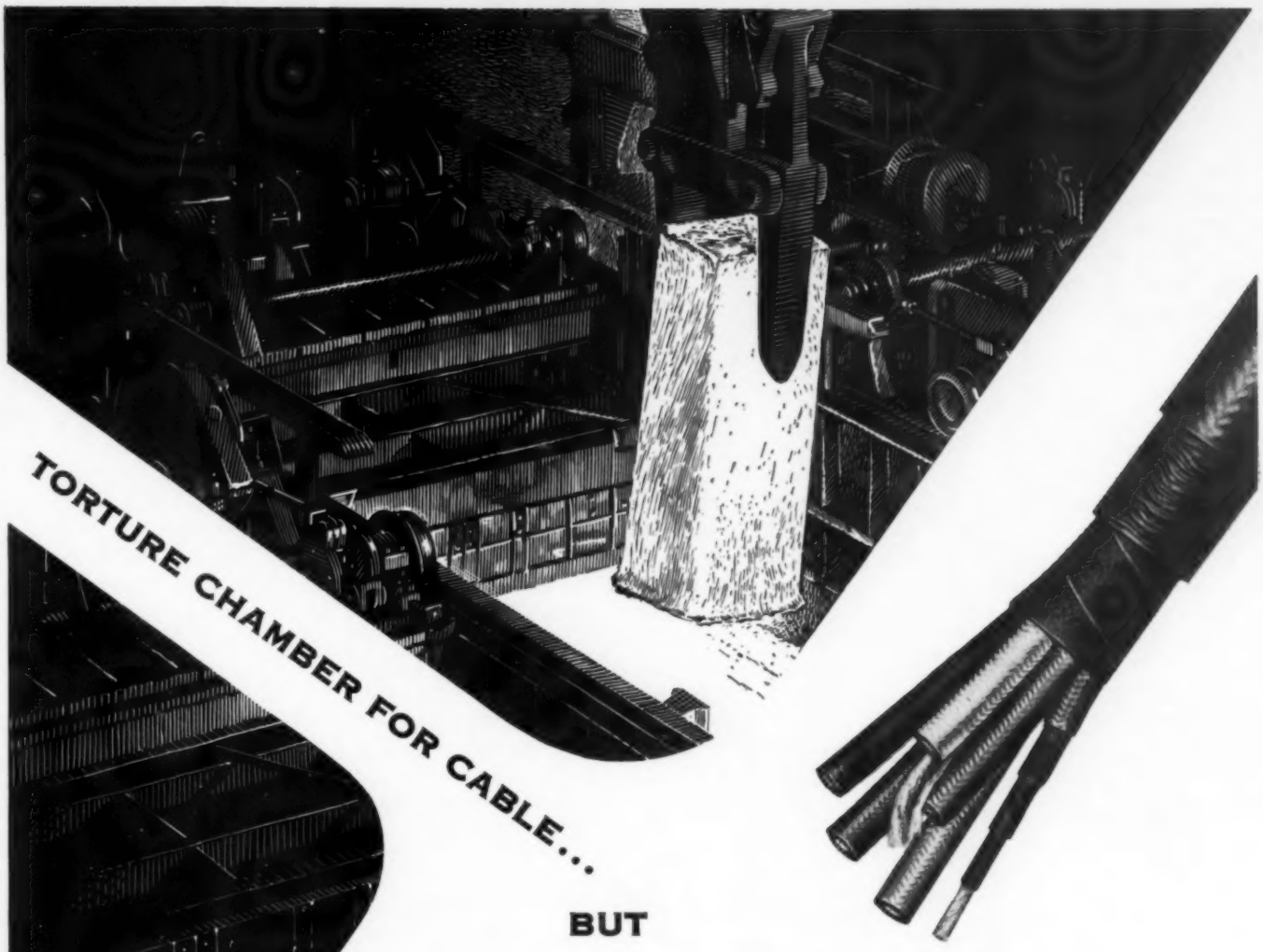
The yield in liquid steel was reported as "at least 90 per cent." Spitting and losses due to nose sculls are low. When large ingots are poured a yield of 97.8 per cent is claimed, giving a total ingot yield of 88 per cent.

The need for high purity oxygen was stressed. Oxygen consumption (calculated theoretically as 1890 cu ft per net ton of steel) has been 1940-2015 cu ft per ton at Linz.

Mr. Trenkler stated that the economics of the new process are favorable, and it therefore might be expected to find application in most steel producing countries. Definite advantages were claimed particularly in those areas where scrap shortages resulted in the need for high iron consumption, especially when the ordinary bessemer blowing practice with air was not feasible due to quality requirements or the analysis of the available iron.

The discussion of the process was concluded with the following claims for steel produced by the Linz process:

a. Less segregation than that found in open hearth steels of similar composition.
b. Excellent cold working properties.
c. Superiority over open hearth steels for tin plate and wire production.
d. Less brittleness than open hearth steels.
e. Good resistance to corrosion.



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PITTSBURGH STEEL STARTS NEW 66-IN. HOT STRIP MILL

▲ A new 66-in. semi-continuous hot strip mill, one of the fastest of its type in the world, has begun operation at the Allenport, Pa., works of the Pittsburgh Steel Co.

The hot strip mill is part of a $62,800,000 expansion program designed to place the company in the flat-rolled products market. Pittsburgh Steel in the past has been known primarily as a producer of ingots, seamless tube, and wire products.

At present, the mill can produce steel sheets at a rate of about 1770 fpm. Ultimately it will be able to roll at a much faster rate. Current monthly production will be limited to 50,000 net tons.

Facilities for cold rolling steel sheet, which are under construction adjacent to the hot mill, are expected to be in operation in the latter part of this year. Hot and cold rolled sheet and strip production will then build up to 600,000 net tons per year. This will be in addition to the company's production of seamless tubular products and wire products.

phases of this program are coming down the home stretch.

The Allenport hot mill and finishing facilities are housed in new buildings covering an area of 350,000 sq ft located on the Monongahela River about 25 miles south of Pittsburgh.

Steel slabs, rolled at Pittsburgh Steel's Monessen works, five miles downriver from Allenport, are barged to the new hot mill. Unloaded at a newly completed dock installation, they are inspected, scarfed, and placed in stock in a slab storage yard.

From the storage yard, slabs move to the charging end of two heating furnaces, where they are fed one at a time into the furnaces by a magazine feeder and automatic pushers.

Slabs are heated in two triple zone gas furnaces, 22 ft wide and 80 ft long. Each contains two sets of water cooled skids. These furnaces have burners at the top and bottom, and will heat slabs to rolling temperature at a rate of about 160 tons of cold steel per hr. Precision control enables the heater to develop the right temperature for best results in rolling. Temperature of the steel is checked by radiation type pyrometers as the slabs are discharged from the furnaces to the roller table.

The roller table starts the slab on its way through the mill, where it first passes through a scale breaking stand driven by an 800-hp induction motor to crack the scale. Loose scale is then removed by water sprays under a pressure of 1000 psi.

From the scale breaker, the slab is fed to a four-high reversing roughing mill, which in five passes reduces a 5-in. thick slab to 0.525-in. strip. This unit is powered by a 6000-hp, 40/100-rpm twin-drive motor con-

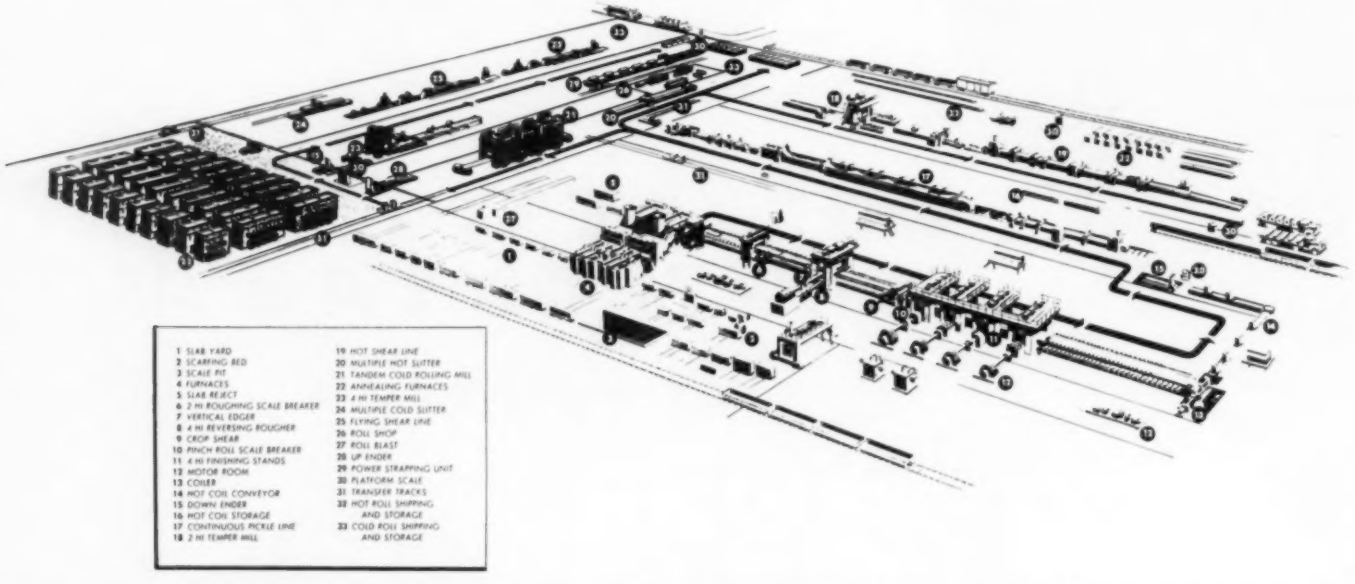

Figure 1 — Schematic shows facilities planned for hot and cold rolling mills. These mills mark the entrance of Pittsburgh Steel into the sheet steel market. Hot mill is now in operation, but some of the cold mills will not be completed until later in the year.

Completion of the hot mill concludes another step in the company's program of progress, begun in 1950, which includes: (1) an increase in blast furnace capacity by 12 per cent; (2) an increase in open hearth capacity by 50 per cent; (3) construction of five new soaking pits and installation of a new 66-in. high-lift blooming-slabbing mill; (4) an increase in finishing facilities of 82 per cent. All

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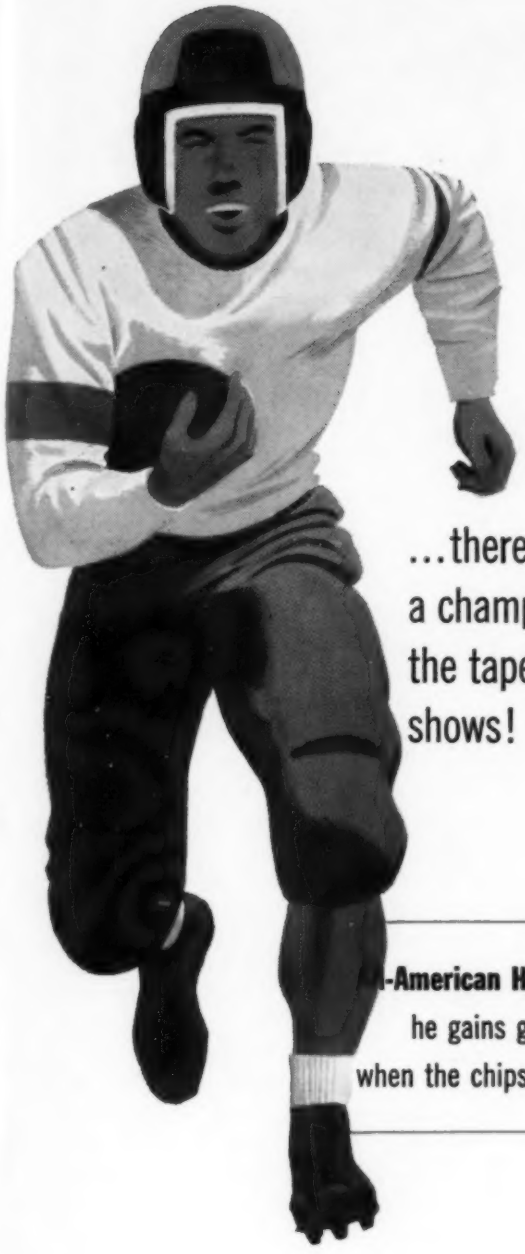

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Figure 2 — Two 40-ton cranes in the slab conditioning department operate above the scarfing gantry crane. About 45,000 tons of slabs will be kept in this storage.

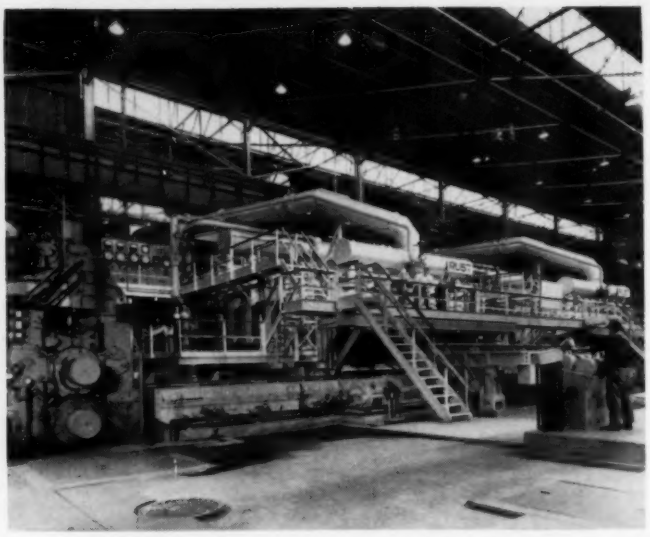

Figure 3 — Triple-zone gas furnaces heat slabs at rates of about 160 tons of cold steel per hour. Furnace temperatures range from 1650 F at the entry end and 2400 F at the discharge end.

sisting of two 3000-hp, 600-volt mill-type reversing motors. The vertical edging rolls of this stand are driven by a 600-hp, 450-volt, d-c reversing edger motor.

After emerging from the rougher, slab temperature is checked by a recording and indicating pyrometer, ends are cropped off and the steel is given another descaling in a second scale breaking unit before passing into the first of four 4-high finishing stands in tandem, each driven by a 4000-hp, 600-volt, d-c motor. The stands are spaced on 18-ft centers. Looper tables between the stands keep the desired tension on the steel sheet.

An 8000-hp synchronous motor-generator set, which includes three 1750-kw, 600-volt, d-c generators for the reversing-roughing mill and one 500-kw, 450-volt d-c generator for the edger, supplies adjustable voltage power for the roughing drive.

Two 5000-kw, pumped-mercury rectifiers convert power from 25,000-volt, 3-phase, 60-cycle, a-c to 600-volt d-c for the finishing-stand motors. The Allenport installation represents the third time in the United States that mercury rectifiers have been used to convert all the power for the finishing train of a hot strip mill.

Leaving the finishing train, the steel is cooled by water sprays on its way to the coiling pit. The thickness is accurately controlled by an X-ray gage.

The runout table uses a total of 177 3-hp motors to move the strip from the finishing stand to the down coiler which is driven by a 300-hp mill motor. More than 2500 hp of small auxiliary d-c motors are included in the drive equipment installed in the new mill expansion.

Finished coils are placed on conveyors and carried to coil storage for further cooling. Controlled cooling establishes a uniform grain structure to assure fine quality steel.

Provision has been made in the construction of the mill for future addition of two more heating furnaces, two more finishing stands, a flying shear, and one more coiler. Installation of these units ultimately will provide a doubling of capacity and an increase of rolling speed.

The size range of sheets that can be rolled runs from 20 to 60 in. wide. Thickness of finished sheets ranges from 0.065 to 0.188 in. Most of the

Figure 4 — The 4-high reversing rougher is driven by two 3000-hp motors. In five passes, the slab is reduced from about five to about ½ in. A 20-foot slab entering the mill emerges nearly 200 feet long in approximately one minute.

Figure 5 — Sheet is delivered to the runout table at speeds up to 1770 fpm at gages down to 1/16 in.

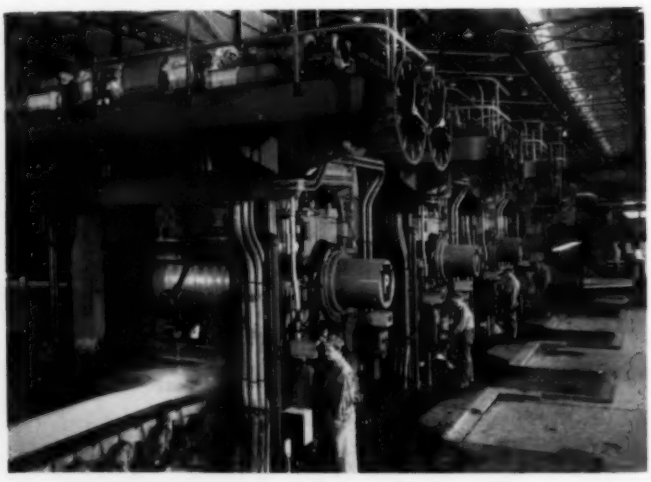

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Figure 6 — Coils come off the line at a rate of about one every two or three minutes.

steel rolled will be in low carbon grades—rimmed steel with less than 0.25 per cent carbon and a manganese content less than 0.60 per cent. Capped steel, semi-killed steel, and killed steel will also be rolled.

Hot rolled coils, once they are cooled, may be shipped or may receive further processing. The Allenport hot mill is equipped with a modern continuous pickle line. About 40,000 tons of sheet steel per month, 20 to 60 in. wide, can be cleaned, trimmed, and oiled.

The pickle line includes a series of units for straight-line continuous processing of sheet steel. Coils are fed into a processor, which bends the sheet backward and forward sharply over a series of five small rolls, loosening the mill scale and levelling the sheet at a rate of up to 1000 fpm. Next, the ends of the coils are sheared off evenly.

The coils of steel are then welded or stitched end to end to form a continuous ribbon of steel. If welded, the sheet is fed into a flash-welding machine, where the end of one coil is butted against the trailing end of the preceding coil, and welded to it. Excess flash is removed in a trimmer. The weld is inspected and the continuous steel sheet is run into a looping pit. If stitched, the end of one coil is lapped over the trailing end of the preceding coil and the two ends are clamped and punched. Then the steel sheet runs out into the looping pit.

The pickle line consists of four 70-ft pickling tanks, made of ⅜-in. steel, rubber lined, with three courses of acid-resistant brick to protect the rubber. These tanks hold a strong sulphuric acid solution at a temperature of about 205 F. The total time of immersion when pickling at top speed averages about 45 sec. This permits an average pickling speed of approximately 275 to 300 fpm on regular low carbon steel.

The delivery end of the acid tanks are equipped with wringer rolls, followed by a cold water rinse, a hot water rinse, another set of wringer rolls, and a hot air dryer.

The continuous sheet of steel is now sheared again to coil length. A side trimmer slits off the edges of the steel to finished width. Scrap balers, located under the floor level, dispose of edge scrap. The steel is oiled, and recoiled—this time to coils with a maximum diameter of 6 ft, and a coil weight of up to 30 tons.

Coils of cleaned sheet are now ready for shipment, hot mill finishing, or cold mill finishing when the cold mill installation is completed. Hot mill finishing units now in operation include a two-high temper mill and a hot shear line.

At the temper mill, coils are fed between two rolls to a tension reel at speeds up to 1340 fpm. The rolls smooth out the surface, and give the steel a slightly harder "skin" than the core has. Inspectors take samples from the steel to test its mechanical properties.

The hot shear line is built to side-trim the steel and cut sheets to lengths of 3 to 30 ft on a flying shear. It is also equipped with a roller leveller, housing 17 levelling rolls with back-up rolls to assure accurate flatness.

Figure 7 — Overall view of motor room for new hot strip mill at Pittsburgh Steel's Allenport Works.

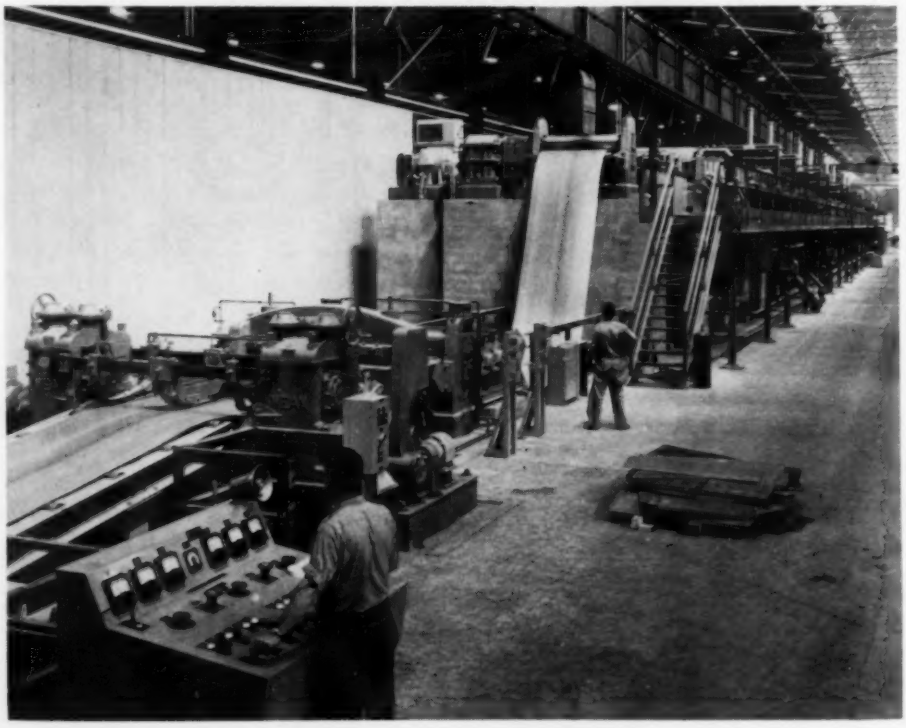


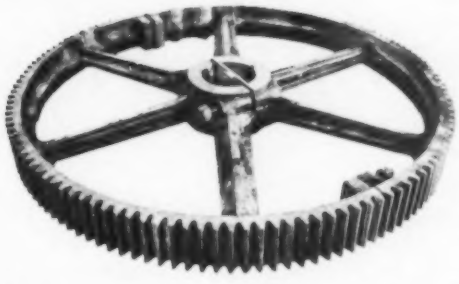
Figure 8 — Coils of sheet steel feed through the pickle line, consisting of four pickling tanks each 70 feet long. These tanks contain a strong solution of sulphuric acid at about 205 F. Total time of immersion, when the line is moving at top speed, is about 45 seconds. The delivery end of the line is equipped with wringer rolls, rinse tanks, another set of wringer rolls and a hot air dryer.

FAST REPAIRS
OF HEAVY PARTS with THERMIT

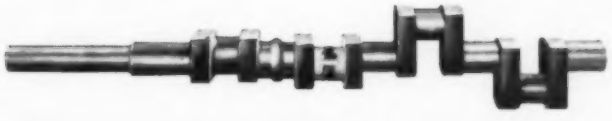
- **Cuts downtime**
- **Eliminates costly replacement**
- **Repair outlasts original unit**

Thermit is used extensively for pinion gear repair.

Heavy machine frame repaired by Thermit Welding.



Crankshaft, 8" in diameter, was restored to duty by Thermit after being broken.



3 fractures in this large ring gear were quickly repaired by Thermit Welding.

When industrial equipment breaks down, the most important problem is to get it back in service—and FAST! Thermit Welding has answered this need time and again . . . in a variety of plants . . . for a variety of parts. Thermit requires a minimum of technical skill . . . gives consistently sound welds . . . is more economical than part replacement. Thermit repairs are permanent repairs.

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An oiling machine coats the steel to prevent corrosion during shipment to users. Stacks of sheets, which emerge, are weighed and readied for shipment.

When the cold mill installation is completed, a large percentage of pickled coils of steel will be fed directly to the cold mill for further reduction, annealing, temper rolling, shearing, and resquaring.

A power company substation with an incoming voltage of 132 kv and 40,000 kva transformer capacity steps the voltage down to 25 kv to supply the entire Allenport works. Included in the power distribution equipment are four outdoor circuit breakers at the utility substation with an interrupting capacity of 1,000,000 kva. These breakers handle the electrical load of the existing tube mill and the new hot mill.

An outdoor packaged substation with a 15,000-kva transformer, two 7500-kva transformers, and metal-clad switchgear reduces the incoming voltage to 13.8 kv and 2.4 kv to supply power for the hot-mill operation.

Indoor 13.8-kv metal-clad switchgear feeds the 250-volt, d-c rectifier equipment, the hot strip mill motor-generator set, and the 480-volt unit substations. A lineup of 2400-volt indoor metal-clad switchgear is provided to distribute power to the pickle line, hot-roll sheet temper mill, and shear line.

Three 1500-kva unit substations supply power for the 440-volt equipment, and a 1500-kw, 250-volt d-c unit substation feeds the 250-volt equipment.

A water supply system, containing five miles of large and small diameter mains, provides the mill with between 30 and 35,000,000 gal daily. Gas and oil pipe lines honeycomb the substructure to supply fuel and lubrication for various production units.

In construction of the mill, some 140,000 cu yd of earth and rock were excavated. Over 42,280 cu yd of concrete were poured for foundations. Some 3500 tons of reinforcing steel were used, and nearly 5000 tons of structural steel went into building frameworks.

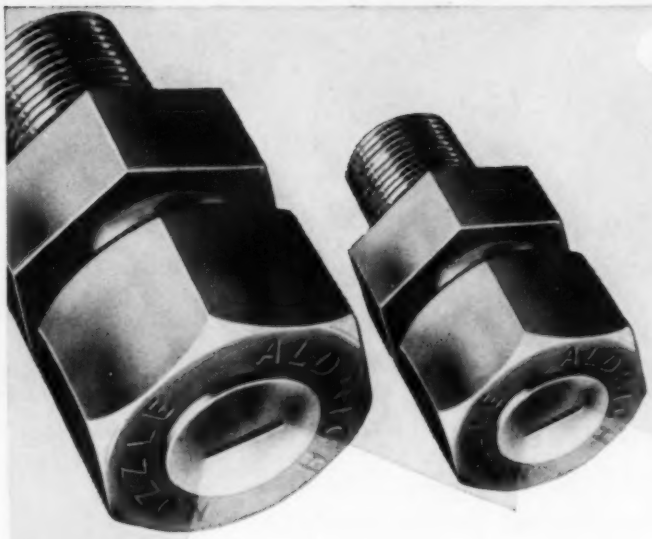
NEW SILICA REFRACTORIES PLANT BUILT AT WINDHAM, OHIO

▲ During 1951 and 1952, the tremendous expansion in the steel and other industries necessitated a corresponding increase in the output of refractories. To meet this need, Harbison-Walker embarked upon the greatest expansion program in the history of the company, at an expense of more than $30,000,000. This program, which affected all of the company's products, included the construction of a new silica refractories plant at Windham, Ohio, and another at Fairfield, Ala. A new fireclay brick plant was erected at Fulton, Missouri, and a basic brick plant at Marelan, Quebec. Other silica and fireclay brick plants were completely modernized and substantially enlarged. Plants at Baltimore, Maryland and Warm Springs, California have added greatly to their capacities to produce the basic refractories magnesite, chrome and forsterite. In June, 1951, the company was operating 18 continuous tunnel kilns; by June of this year the number had increased to 30.

THE NEW WINDHAM PLANT

In the new Windham plant, silica refractories of two types are manu-

Figure 1 — Aerial view of Windham plant.



Why ALDRICH Nozzles Give You EFFECTIVE DdescaLING

1. The sharp, knife-like jet of water and the solid striking force developed by Aldrich Patented Descaling Nozzles give far more effective descaling than nozzles which produce jets of equal force but with a larger impinging area. This has been proved in hot strip as well as billet descaling.

2. By use of Venturi tube design and a rectangular orifice, Aldrich Nozzles produce a cutting spray with an impinging force equal to 95% of the potential energy supplied to the orifice—resulting in thorough descaling without causing excessive cooling due to over-abundant use of water.

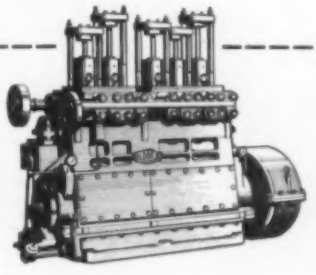
3. Should clogging occur, Aldrich design permits easy cleaning of the orifice disc. When replacement becomes necessary, you need only insert a new disc—NOT AN ENTIRE NEW NOZZLE.

4. Aldrich orifice discs have a 1/32" bevel on the inside circle—preventing too sudden choking of water when it reaches the disc—also preventing undue wear and friction loss.

5. Aldrich discs are capable of withstanding high pressures for long periods of time. They are made of hardened stainless steel, machine ground to uniform contour, then profiled and burnished to a polished finish. This removes the slightest imperfection on the orifice—preventing streaking on the surface of metal being descaled. Every Aldrich disc is hydraulically tested for uniform pattern and force.

6. Whether used for hydraulic descaling of billets, sheets, plates, or small parts—Aldrich Nozzles insure rapid and thorough descaling; prevent excessive cooling; increase roll and pass life; reduce damage to forging dies; reduce delays due to grinding or changing guides, and afford longer service per insert disc.

Several types of Aldrich Descaling Nozzles are available from stock. May we send you complete information? Data Sheet 61-2 is available on request.



Aldrich Direct Flow Pumps used for descaling systems are fitted with automatic by-pass valves which operate with all types of accumulators. Both descaling cabinets and hydraulic systems, for shell forgings and other small to medium forgings, have been designed by Aldrich. Write for literature or recommendations.

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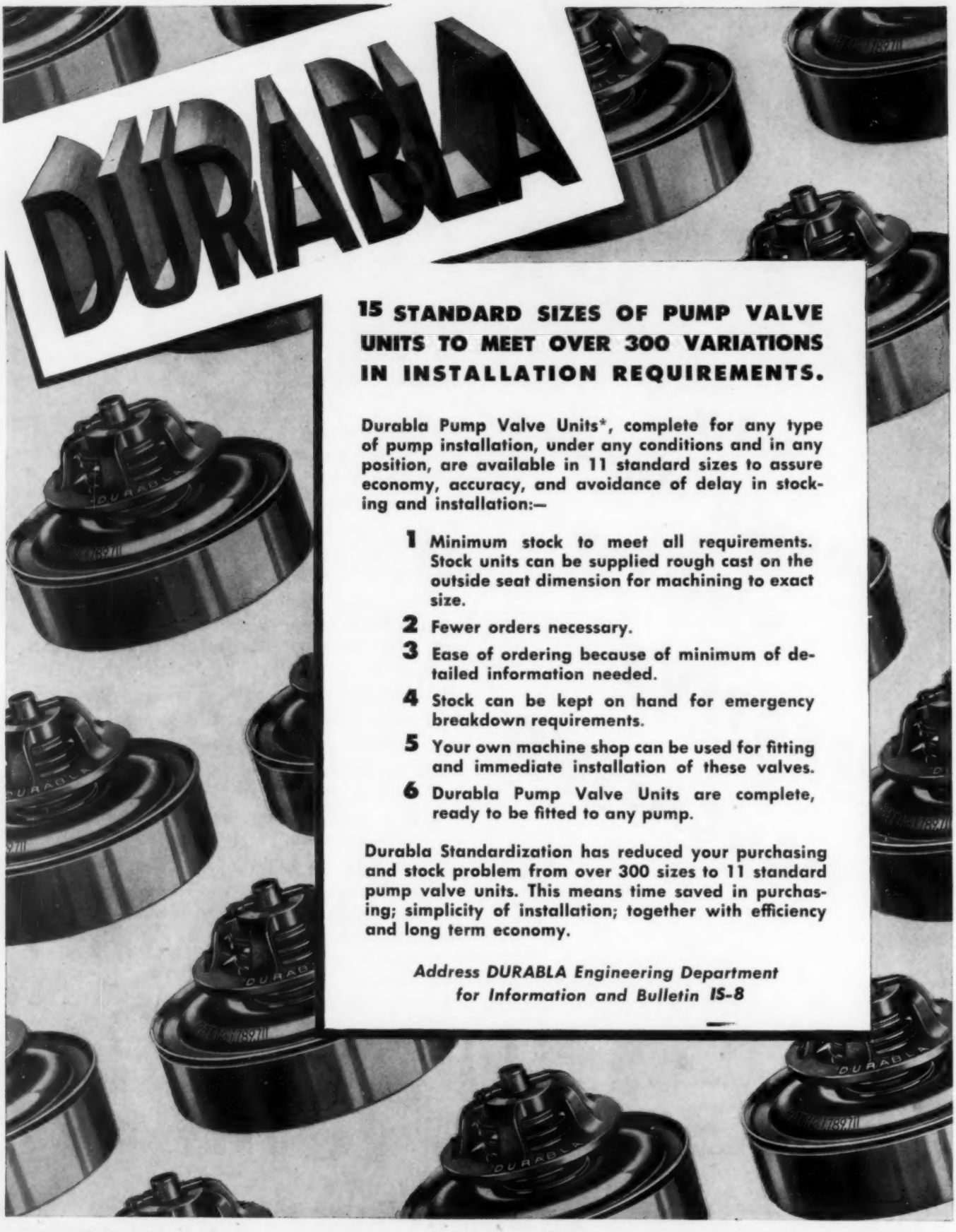

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3. Ease of ordering because of minimum of detailed information needed.
4. Stock can be kept on hand for emergency breakdown requirements.
5. Your own machine shop can be used for fitting and immediate installation of these valves.
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Durabla Standardization has reduced your purchasing and stock problem from over 300 sizes to 11 standard pump valve units. This means time saved in purchasing; simplicity of installation; together with efficiency and long term economy.

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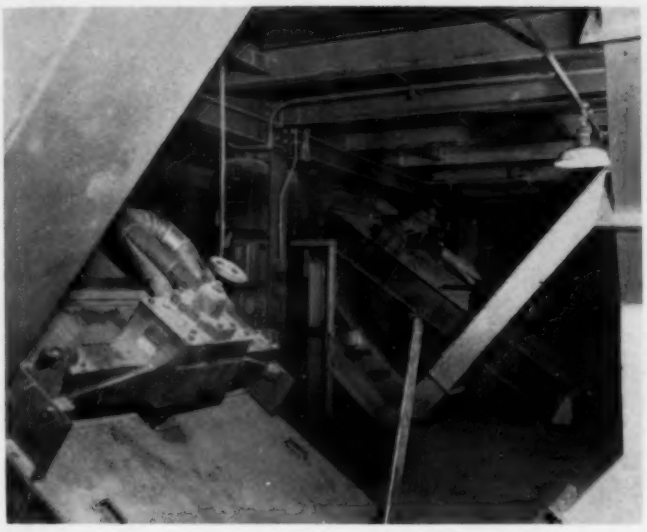

Figure 2 — View of screening units in the dry grinding circuit shows piping for dust collection.

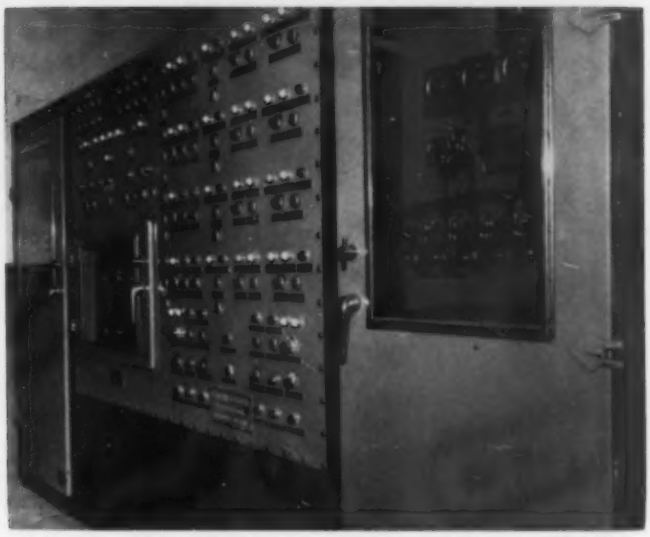

Figure 3 — Panel controls automatic batching and mixing from one location.

factured, Star brand of the conventional type and Vega brand of the super-duty type. The products of the plant are used in by-product coke ovens, open-hearth and electric steel furnaces, glass tanks, furnaces employed in the smelting and refining of copper and other non-ferrous metals, and in a wide variety of other furnaces.

The raw material used is taken from the company's quarry located six miles north of Windham. An aerial view of the plant is shown in Figure 1.

The entire operation was carefully engineered so as to provide for future expansion of the facilities while still retaining the smooth and un-interrupted flow of materials. The plant was erected in 1951 and early 1952. In the construction of the plant, the latest laboratory and pilot plant developments were translated into commercial practice, and full advantage was taken of new concepts and improvements in machine design. Mechanical and electrical controls at every stage of manufacture assure uniformity of product. The newest proved techniques for the reduction of occupational hazards were adopted. The result is a highly mechanized and accurately controlled operation.

Windham Works is the first silica brick plant built since the introduction of super-duty silica brick as a new class of refractories. In the new plant, manufacturing techniques were adjusted for the most advantageous simultaneous production of Star conventional-type silica brick and Vega super-duty brick. Both standard sizes and special shapes of each brand are made. The greater part of the output is made by the power-press process. Some brick are made on an impact press of a type developed and perfected by the company. Special shapes of such design that they cannot be formed mechanically are molded by hand.

The steps in the manufacturing processes include raw material handling and storage, grinding, batching, mixing, forming, drying, firing, finished product storing, and shipping.

The raw material used in the plant is a silica conglomerate rock of the Sharon geological formation, taken from a quarry operated by the company six miles north of Windham. The rock recovered is put through a processing plant at the quarry before shipment. All of the rock is crushed; that to be used for making Vega super-duty silica brick is washed and dried; that for making Star conventional-type silica brick is dried but not washed.

From the raw material bins the crushed rock is fed by electrically vibrated feeders to totally-enclosed dry-pan grinding mills. The product of these pans is divided by sizing screens into several fractions, and the sized material is distributed by chutes or conveyors to the various compartments of the ground material bins. A certain proportion of the material from the dry pans is fed to ball mills by means of carefully regulated belt feeders, for fine grinding. The ball mills are controlled by electric ears and deliver their materials to the proper ground material bins by means of bucket elevators.

Following the grinding of the raw material and its classification in accordance with particle size, the fractions must be re-assembled in proper proportions in preparation for forming into the various sizes and shapes of brick.

Much study and planning went into the design of the batching system. The materials are automatically discharged from the selected ground material bins in the desired proportions by weight, batched, and delivered to the mixers. The material from the bins can be delivered to any of the several mixers by simple adjustment of the control panel. If operation of any portion of the batching system is interrupted, the entire system automatically shuts down, and a horn notifies the operator. The exact location of the part needing attention is indicated on the control board.

The mixers in which the batch is given its final processing in preparation for molding consist of totally enclosed stationary pans having rotating mullers and scrapers. The mixers are so connected to the batching system as to receive all of materials in predetermined sequence. The mixing times are standardized. At the end of the time allotted, the contents of the mixer are discharged into tram buckets. When filled, the buckets are delivered to the presses or special-shape molding stations, where they are discharged electrically by the tram operator.

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In any application where magnets are subjected to severe blows, you need the extra structural strength of Ohio Magnets.

Take this rugged Ohio Welded Magnet. Outer ring is a single casting welded to top plate on top where weld can't get dented in. Add to this Ohio's strap-wound copper coils . . . longer-lasting insulation . . . non-remelting or asphaltum filling compound . . . armored terminal boxes.

No wonder Ohio Magnets require less maintenance. So for extra magnet life, extra magnet value — specify Ohio Magnets. Remember, Ohio Magnets lift larger loads longer — *especially with Ohio Magnet Controllers.* Send for Bulletin No. 112. Offices in principal cities listed in Classified Directory.

OHIO WELDED MAGNETS. 39 to 65" diameter. Lightweight models in 39 & 45". 6-coil types in 46, 55, 65"; 8-coil in 55 & 65". Weld on top where it can't get dented in. Also capsule coil over 45".

OHIO BOLTED MAGNETS. 12 to 65" diameter. 6-coil types in 39 to 65"; 8-coil in 55 & 65". Strap copper coils over 39". Bolts protected in recessed wells. Also capsule coil over 45".

OHIO BASKET MAGNETS. 55 & 65" 4-coil, & 65" 6-coil. For extra heavy-duty service; hefty ears project beyond magnet diameter, ward off damaging blows. No weight carried by bolts. Also capsule coil over 45".

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The power presses and the impact press are automatically fed by means of carefully controlled belt feeders. The pressed brick are delivered from the press by means of standard pushers or by means of mechanical pickers. The press operators set the standard sizes of brick directly on the tunnel kiln cars. This feature of direct setting, which helps workmanship by eliminating one handling, is an innovation built into the Windham plant, and was never before accomplished anywhere, for silica brick. The larger and more intricate brick shapes are usually set on pallets, which are then placed on monorail-supported rack cars.

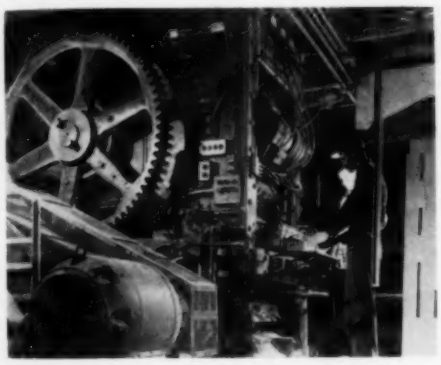


Figure 4 — Power press has automatic setting of brick on tunnel kiln cars.

The tunnel kiln cars containing undried brick are transferred by means of transfer cars and gasoline-driven pushers to tunnel kiln car dryers, and are moved through the dryers in accordance with a pre-determined schedule. There is a kiln car dryer in line with each of the tunnel kilns. This facilitates the rapid movement of a car from the dryer into the entrance end of the kiln with a minimum of temperature-drop. The dryers are supplied with clean hot air from the cooling zone of the kilns. A system of fans and ducts is arranged to insure the movement of the warm air throughout the complete cross section of the kiln car load. Indicating and recording instruments are used to observe the temperature and humidity conditions in the dryer.

The Windham tunnel kilns were completely designed by Harbison-Walker's engineering department, taking full advantage of the experience gained in the operation of tunnel kilns at other company plants. The kilns are 567 ft long, each holding 81 cars, and have a load cross section of 6 x 5 ft. The firing cycle may be varied to suit the required production. The kilns are equipped to burn heavy oil. Each oil line has a parallel small steam line to heat the oil to a temperature at which it will be fluid enough to flow. The two lines are wrapped together and insulated.

The kilns are provided with both thermocouple and radiomatic instruments for measuring temperatures. This instrumentation allows the operator to set up any desired firing curve within rather wide limits. It also permits close adjustment of individual burners so that uniform heating conditions can be maintained.

In the firing of silica brick, a permanent increase in dimensions occurs, altering the individual brick from the green or mold size to the fired size. This expansion amounts to about 15 per cent by volume. It results from the transformation of the silica mineral quartz into other crystalline forms of silica. Completion of the expansion to the optimum degree requires extended time as well as high temperature. This is the primary reason for the great length of the Windham tunnel kilns.

OUTSTANDING FEATURES

In the design and operation of the Windham plant, the following features are considered outstanding:

1. Methods of handling and storing raw materials.
2. Grain size control (achieving the correct grading of particle sizes and then maintaining it by avoidance of segregation in bins).
3. Precision of batch control.
4. High pressure at which the brick are formed.
5. Impact pressing.
6. Direct setting of brick from presses to tunnel kiln cars.
7. Uniformly high burning temperature.
8. Mechanized handling of brick (by palletization and lift trucks).
9. Dust collection.
10. Laboratory testing program for continuous quality control.

Figure 5 — Unburned brick is entering kiln car dryer. On left are monorail tracks at entrance end of "rack car dryer."

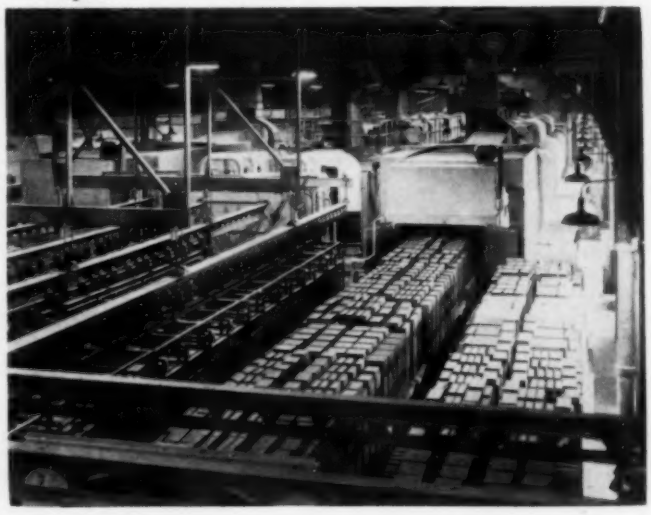


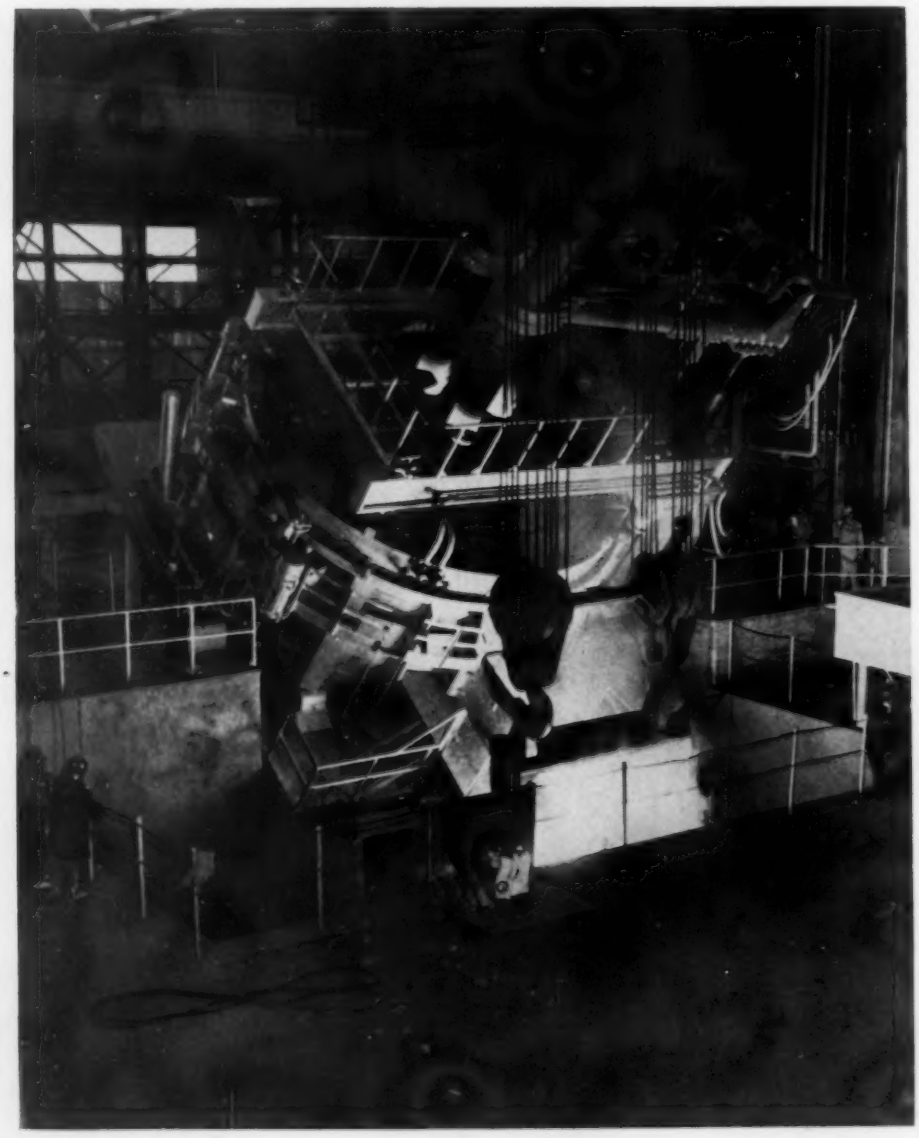
Figure 6 — Fired brick leaving tunnel kiln moves onto a transfer car.

ELECTRIC FURNACE CHALLENGES OPEN HEARTH

▲ A possible saving to the steel industry of many millions of dollars annually is indicated by the report on a two-year research project at the Battelle Memorial Institute just completed by fourteen electric utility companies and the bituminous coal industry.

Approximately 83,000,000 tons or 89 per cent of total United States steel is made in open hearths. Most of this is low-carbon steel. The electric utility industry and the coal industry, knowing that both would benefit materially if electric furnaces replaced open hearths, joined forces to conduct a comprehensive technical-economic study to discover whether the electric furnace could compete with the open hearth for this major part of the nation's steel production.

Figure 1 — This type furnace is suitable for the production of low-carbon and alloy steels. Unit shown is rated 100 tons.



They discovered that replacing open hearth furnaces by electric furnaces could: (1) decrease the cost of making low-carbon steel from cold metal up to $3.15 per ton, (2) increase the national output of electricity by 12 per cent, and (3) increase coal production about 25,000,000 tons a year. The latter two estimates assume a total replacement of the existing 950 open hearth furnaces by 760 electric furnaces. Even a 10 per cent switch to electric furnaces in the near future holds tremendous importance to the industries concerned.

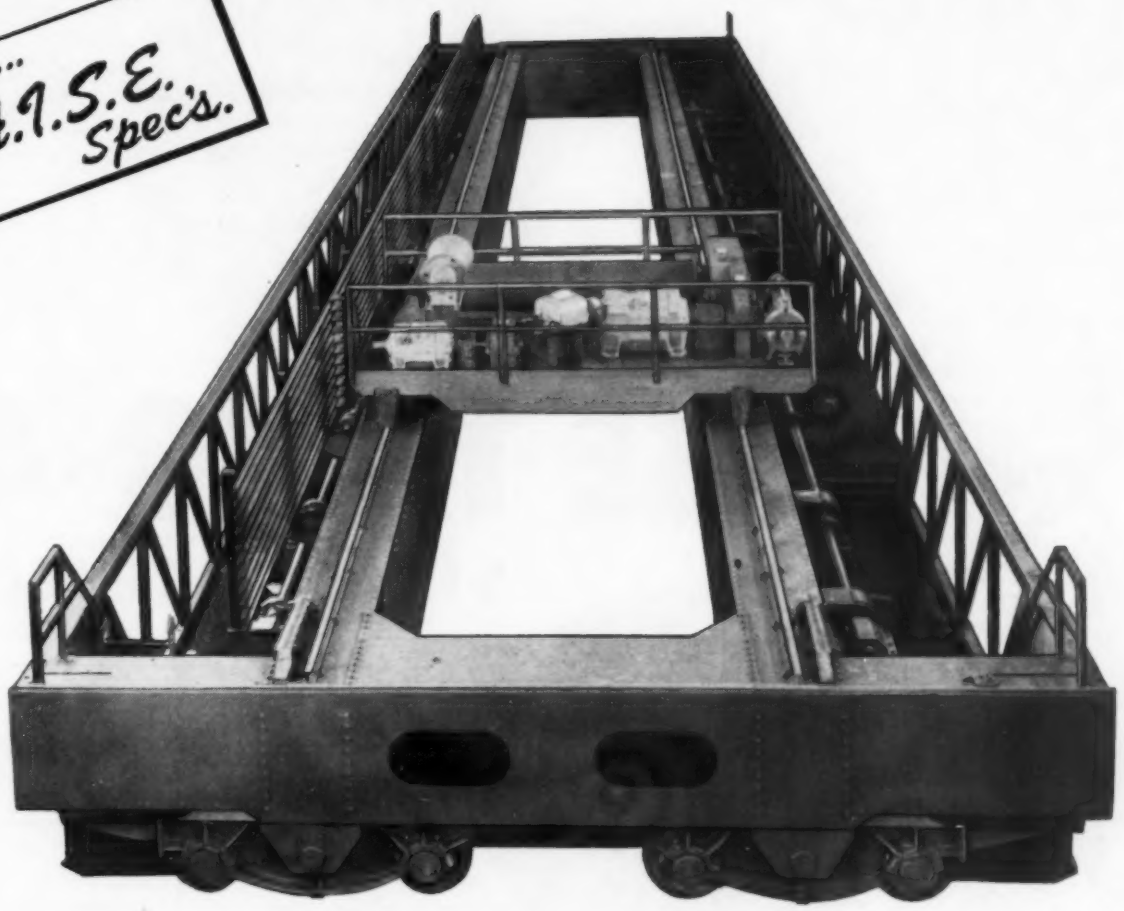
Three plant sizes were studied: 250,000 tons, 500,000 tons, and 1,000,000 tons of annual steel production.

Only the most modern open hearth installations were used for the study. No plant more than eight years old was included. Costs shown for open hearth operation are the lowest which have been achieved or which the steel industry considers to be possible. For the electric furnace, costs have been used which are conservative and beyond challenge. Three representatives of the steel industry advised on the collection of data and preparation of the final report.

WHY ELECTRIC FURNACES NOW CHALLENGE THE OPEN HEARTH

Up to the present, electric furnaces have been used primarily for the pro-

to... A.I.S.E. Spec's.



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by "Shaw-Box"

This 25-ton "Shaw-Box" Crane, 100'-0" span, was built to A.I.S.E. standard No. 6 specifications. When your cranes are by "Shaw-Box" to these specifications, you get more crane for your crane dollar as you pay less for engineering. "Shaw-Box" already has standard A.I.S.E. designs for cranes ranging from 15 to 100 tons capacity.

In "Shaw-Box" Cranes, you get cranes built exactly to your specifications plus the advantages of "Shaw-Box" engineering, manufacturing techniques, fine workmanship, performance, and maintenance conveniences that have built an enviable reputation for all "Shaw-Box" equipment.

SEND ALL YOUR INQUIRIES FOR CRANES AND SOAKING PIT CARRIAGES TO "SHAW-BOX".

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silica refractories...

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SILICA CEMENT

Tayco-40 High-Temperature Silica Cement is unsurpassed for bonding silica and super-duty silica brick and shapes. Spalling is definitely retarded when furnace roofs and side walls are laid with Tayco-40. Having a softening point nearly equal to the best grades of silica brick, Tayco-40 will *not* run out of joints at temperatures up to 3100° F.

Tayco-40 has excellent water retention properties which make it the most workable, easy-to-use silica cement obtainable. Use it for dipped, poured or trowelled joints. When applied to porous silica brick, Tayco-40 remains plastic longer, allowing ample time for proper laying and fitting of the brick. Because of its smooth workability, Tayco-40 goes 2½ times as far as ordinary silica mortars. Thinner, tighter joints are obtained; losses in mixing and handling are reduced.

The majority of steel mills in the United States have found it economical to use Tayco-40. Try Tayco-40 for hot repairs and for your next furnace re-build. Properties and service data are given in Bulletin 507. Write for your copy.

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duction of special alloy steels. During World War II, electric furnace steel-making expanded to supply increased demands for high quality steels. At the end of the war, demands for these steels declined and excess electric furnace capacity led some manufacturers to experiment in using this equipment to manufacture low-carbon steel. About the same time, important developments and improvements in equipment, such as the swing roof, high rates of energy input, and increase in furnace size, took place. These improvements reduced charging time, decreased melting time, and lowered current consumption. As a result, important economies were achieved which brought electric furnace steel-making costs to the level of the open hearth process.

The comprehensive evaluation just completed proved what had been indicated by the isolated experiments of individual steel companies who used the electric furnace to make low-carbon steel.

An 80-page report* on the project shows that capital cost for electric furnace installations is only 60 per cent the cost of open hearths; that the cold melt steel-making process using scrap and pig iron shows lower cost for the electric furnace, and that electric furnaces show a greater annual return on invested capital. For the 50 per cent hot metal—50 per cent scrap metal process, annual return on invested capital with the electric furnace is equal to or greater than the open hearth. The study and report were based on full capacity operation. Less than full capacity operation would tend to favor the electric furnace because fixed costs are lower.

OTHER ELECTRIC FURNACE ADVANTAGES

In addition to reduced capital investment, and reduced cost of steel production in cold-melt practice, the electric furnace offers steel company management other important advantages over the open hearth.

1. The electric furnace is more flexible. It can be put into production or withdrawn at will while the open hearth must be fired even when idle in order to protect the brick work.

2. Electric furnaces can be kept in operation all but about 15 days a year while open hearths are usually down about 30 days. Rebuilding time is shorter for the electric furnace.

3. The yield of the electric furnace is about 2 per cent greater than the open hearth for the same amount of materials.

4. The electric furnace gives greater control of sulfur which is important in the production of high-quality deep drawing sheets and welding grades of steel.

5. Because of its better temperature control the electric furnace saves time in steel production. Nitrogen control by the electric furnace is expected to match that of the open hearth.

6. Open hearths are fired primarily with liquid and gaseous fuels; electric furnaces operate on power usually generated from coal. Future changes in costs of fuels and metals used by the electric furnace and the open hearth are expected to favor the electric furnace.

The project report contains detailed tables showing not only costs, but also operating data: pounds, gallons, manhours, etc., so steel companies can readily apply their own operating and cost data to evaluate electric furnaces versus open hearths for their own plants.

OTHER INDUSTRIES ALSO PROFIT

Manufacturers who supply or service the coal, electric, and steel industries also stand to increase sales by many millions of dollars. For example, the 25,000,000 tons of coal needed annually for generating the additional electricity would mean $25,000,000 worth of mining equipment. This tonnage means millions of dollars in freight revenue to the railroads and other transportation companies. Supplying power for the electric furnaces for the maximum potential steel tonnage would mean installation of 19,000,000 kw of additional capacity. To build and equip these power generation facilities would take an investment of $3,000,000,000, not including transmission. The electric furnace installations would mean over $1,000,000,000 in sales to manufacturers of furnaces and auxiliary equipment.

*Copies of this report may be purchased from Bituminous Coal Research, Inc., 2609 First National Bank Building, Pittsburgh 22, Pa.

AID DEFENSE

MORE SCRAP TODAY . . . .

MORE STEEL TOMORROW.

GET IN THE SCRAP TO KEEP STEEL COMING.

NON-FERROUS SCRAP IS NEEDED TOO!

HINTS FOR CURING SULPHATED BATTERIES

▲ A "sulphated" battery is one which has been undercharged to the point where abnormal lead sulphate has formed on the plates. When this occurs the chemical reactions within the battery are impeded and loss of capacity and complete failure may result. Gould-National Batteries, Inc. suggests an eleven point program to "cure" a sulphated battery plus six causes of sulphation which should be avoided. It is important to detect a sulphated battery as soon as possible. The sooner treatment is started, the less the damage from sulphation will be, and the earlier the battery can be returned to service.

Here's how you can diagnose a sulphated condition. All cells of a sulphated battery will give low specific gravity and voltage readings. An internal inspection will disclose negative plates having a slate-like feeling, sulphated negative-plate material being hard and gritty and having a sandy feeling when rubbed between thumb and forefinger. The internal inspection should be made after a normal charge since a discharged plate is always somewhat sulphated. A normal fully charged negative plate is spongy and springy to the touch and gives a metallic sheen when stroked with the fingernail or a knife. A sulphated positive plate is a lighter brown color than the normal plate.

Most cases of sulphation are caused by:

1. *Undercharging, partial charging, or neglect of equalizing charge* — When a battery is charged repeatedly at low rates the acid is not effectively driven out of the plates, particularly the lower parts, and sulphation results. Repeated partial charges, stopping before there has been sufficient gassing to effect a thorough mixing of the electrolyte, results, in sulphation. It is difficult in normal battery operation to determine just when sulphation begins, and only by giving periodic equalizing charges and comparing individual cell specific gravity and voltage readings can it be detected in its early stages and corrected or prevented.

2. *Standing in a partially or completely discharged condition* — Permitting a battery to stand in a partially discharged condition allows the sulphate deposited on the plates to harden and the pores to close. Batteries should be charged as soon as practicable after discharge and not allowed to stand in a completely discharged condition for more than 24 hours.

Figure 1 — In sulphated batteries, internal negative plates have a slate-like feeling and internal positive plates are a lighter brown color than the normal plate.

3. *Low electrolyte* — If the level the electrolyte is permitted to fall below the tops of the plates, the exposed surfaces will harden and become sulphated.

4. *Adding acid* — If acid is added to a cell in which sulphation exists, the condition will be aggravated.

5. *High specific gravity*—In general the higher the fully charged specific gravity of a cell, the more likely is sulphation to occur and the more difficult to reduce. If, in any battery, there exist cells of which the specific gravity is more than 0.015 above the average, the possibility of sulphation of these cells will be increased.

6. *High temperature* — High temperatures accelerate sulphation, particularly of an idle, partially discharged battery.

Thorough and careful attention to the following steps often will restore a sulphated battery to good operating condition.

1. Clean the battery.
2. Bring electrolyte level to proper height by adding *water*.
3. Put battery on charge at the prescribed finishing rate until full ampere hour capacity has been put into the battery based on the 8-hr rate. If at any time during these procedures the temperature of the battery exceeds 110 F, reduce the charge rate to maintain temperature at or below this point. If any cell gives low readings (voltage 0.2v less than the average cell voltage of the battery), remove and repair the cell before continuing with the procedure.
4. Continue to charge at the finishing rate until the specific gravity shows no change for a 4-hr period with readings being taken hourly. Record voltage and specific gravity readings. Correct specific gravity readings for temperature. These readings indicate the state of charge of the battery.
5. Plate battery on discharge at the 8-hr rate and during the test record individual cell voltages and overall battery voltage at the following time intervals: 15 minutes after test is started, then hourly until voltage on one cell reaches 1.80 and from then on at 15 minute intervals. From this point on the cell voltages should be under constant observation, and the time recorded when each cell voltage goes below 1.75 volts. Terminate the test discharge when the majority of the cell voltages reach 1.75

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volts, but stop the test before any single cell goes into reversal.

6. If the battery gives rated capacity no further treatment is required other than normal recharge and equalization of gravity.
7. If the battery does not deliver near-rated capacity, continue the discharge without adjusting the discharge rate until one or more cells reach 1.0 volts.
8. Recharge battery at the finishing rate as described above, again charging until there is no further rise in specific gravity over a 4-hr period, readings being taken hourly.
9. Discharge again at the 8-hr rate and if the battery gives full capacity, recharge and put into service.
10. If this procedure does not result in full capacity, repeat once more as noted above.
11. If battery does not respond to this treatment, it is sulphated to the point where it is impractical to attempt further treatment and battery should be replaced.

FERROMANGANESE CLEANING PLANT STARTS UP ON DUQUESNE FURNACE

▲ United States Steel Corp. has just placed in operation a new ferromanganese cleaning plant at its Duquesne Works near Pittsburgh, Pa. which will eliminate for the first time the heavy discharge of fume and dust peculiar to ferromanganese blast furnace operation in the past. A comprehensive research program conducted through a pilot plant at a corporation ferromanganese blast furnace plant led to a practical solution of the problem.

The cleaning plant was built by Research Corp., whose engineers cooperated throughout the experimental period at the same time developing sufficient information to design the gas conditioning and cleaning portions of the plant. Work was started on the new installation as soon as assured means of handling the collected dust were developed.

Five electrostatic precipitators with a combined capacity of 135,000 cfm will be used to clean the gas at Duquesne Works. Auxiliary equipment will consist of necessary facilities for handling and disposal of the dust.

U. S. Steel's research men had first to develop means of dealing with the following factors:

For every ton of ferromanganese smelted, approximately 225,000 cu ft of gas is generated. This gas, leaving the conventional primary cleaner, contains 7.5 gr of fine dust and fume in each cu ft. This is equivalent to 14.8 lb to solids in each 1,000 lb of gas.

The dust and fume from ferromanganese furnaces is floury and difficult to handle. Its particle size compares with that of the solids in cigarette smoke. It is pyrophoric and thus

Figure 1 — Last cloud of fume and dust billows from a ferromanganese blast furnace at Duquesne, Pa. works of U. S. Steel, minutes before start-up of a new cleaning plant — first ever built to eliminate these man made clouds from the atmosphere.

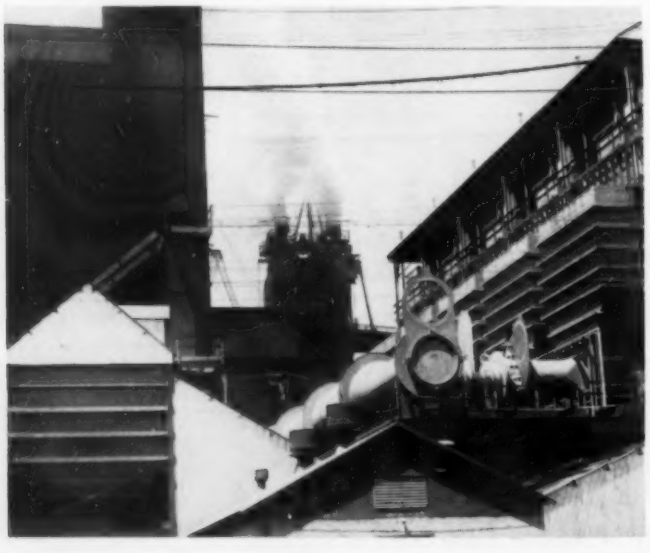

Figure 2 — In contrast to view in Figure 1, clear skies signal start-up of the new ferromanganese cleaning plant. Smoke-free stack is framed between units of the new cleaning facilities.

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may burn spontaneously when exposed to air. It contains many elements undesirable for re-use in the blast furnace and it cannot be dumped or stored without treatment as it would become air-borne in the slightest breeze. Yet, these solids contain about 18 per cent manganese, a critical steelmaking ingredient.

Thus, two problems had to be solved; removal of the dust from the gas and processing the dust after removal.

Two methods of removing the dust from the gas were considered and it was decided that electrostatic precipitation was the only one which could be relied on to give good performance. The alternate method, removal of solids by sonic agglomeration, was finally rejected because development work to date has not proven the practicality of this method.

Electrostatic precipitators, through which the gas flows and is subject to a high tension direct current discharge, capture the solids by electrostatic attraction. Designed to remove 98 per cent of all dust and fume created by the two furnaces, at full capacity, the precipitators will reduce solids to 0.25 lb in every 1,000 lb of gas, or 0.15 gr for each cu ft of gas burned. When combined with normal combustion air, the stack gases will be diluted to approximately half the dust content of the fuel gas.

The smoke control ordinance of Allegheny, where Pittsburgh and Duquesne are located, limits dust to 0.50 or less lb to 1,000 lb of gas, or provides that 85 per cent of dust and fume be removed. Thus the new installation will place the ferromanganese furnaces at Duquesne well within the provisions of the ordinance.

The captured solids from the precipitators are removed by enclosed screw conveyors into five rotary pyrophoring kilns, each capable of processing 1,750 lb of dust an hour. The dust from these kilns is light and floury in texture and extremely resistant to moisture absorption. In order to wet the powder, five continuous mixers have been installed, with two batch type intensive mixers to assure thorough dispersal of moisture in the material before briquetting.

The moistened dust, containing about 14 per cent manganese, will be formed into pillow-shaped briquettes in two briquetting processes with a combined capacity of 10 tons an hour. At the present time, because of alkalies, these briquettes cannot be charged into the furnace.

The briquettes will be stored in outside bins or in piles until such time as a practical method of recovering their ferromanganese content has been developed. The treatment and storage of ferromanganese blast furnace dust is a forward-looking conservation program, which may serve as a possible partial solution to any future manganese shortages, in addition to prevention of atmospheric pollution.

To service the dust-handling and conditioning equipment, auxiliary facilities, including the necessary hoppers, conveyors, motors, controls, shelters and tracks were installed. In addition, transformer capacity has been increased to provide power for the new equipment, and as an additional safety measure the water valves at the central boiler house burner inlets have been replaced with mechanical goggle valves. New gas piping has been installed to connect the clean ferromanganese gas system with the present system. There is expected to be some improvement in operations due to burning clean gas in the plant's boilers.

This plant is the result of many years of study. It is estimated that the United States Steel Corp. spent well into six digits before a satisfactory answer was found for this cleaning process. Several other methods were tried and discarded in the preliminary work. After the answer had been found in pilot plant form, it was necessary, due to the fineness of the dust caught, to find some way to store this dust without having it blown all over the countryside. The answer was to make briquettes or pellets and this, in itself, required a lot of experimental work. In many of the cleaning processes that have been adopted by various industries both here and elsewhere in the country, there has been generally some sort of a recovery in the form of dollars. In this case, at present there is not only no useful purpose to which this fine dust can be put, thereby getting some return, but it was necessary to develop the briquetting process for the purpose of storing the material. Thus this cleaning plant is one of the finest examples of the desire on the part of industry to clean up the atmosphere, regardless of expense, and make its community a cleaner, happier, and better place in which to live.

The new ferromanganese cleaning plant is only one item on an improvement program being carried out at the Duquesne Works. Since the war there were many assorted rumors about Duquesne Works, some of which indicated that "Duquesne Works was not long for this world." However, the plant came back to life and during the last several years, many major steps have been taken to modernize steelmaking facilities to keep pace with progress in the steel industry.

Another step forward was made with the recent closing down of the sintering plant at Duquesne Works. This particular operation has been a cause of annoyance. The plant was originally scheduled to be closed three years ago, but was kept in operation. One reason for continuing operations at the sintering plant involved the need for supplemental iron ore during high production periods. The second reason was to reduce the large accumulations of flue dust at the Duquesne Works. Ore is now in better supply and the flue dust pile has reached reasonable proportions.

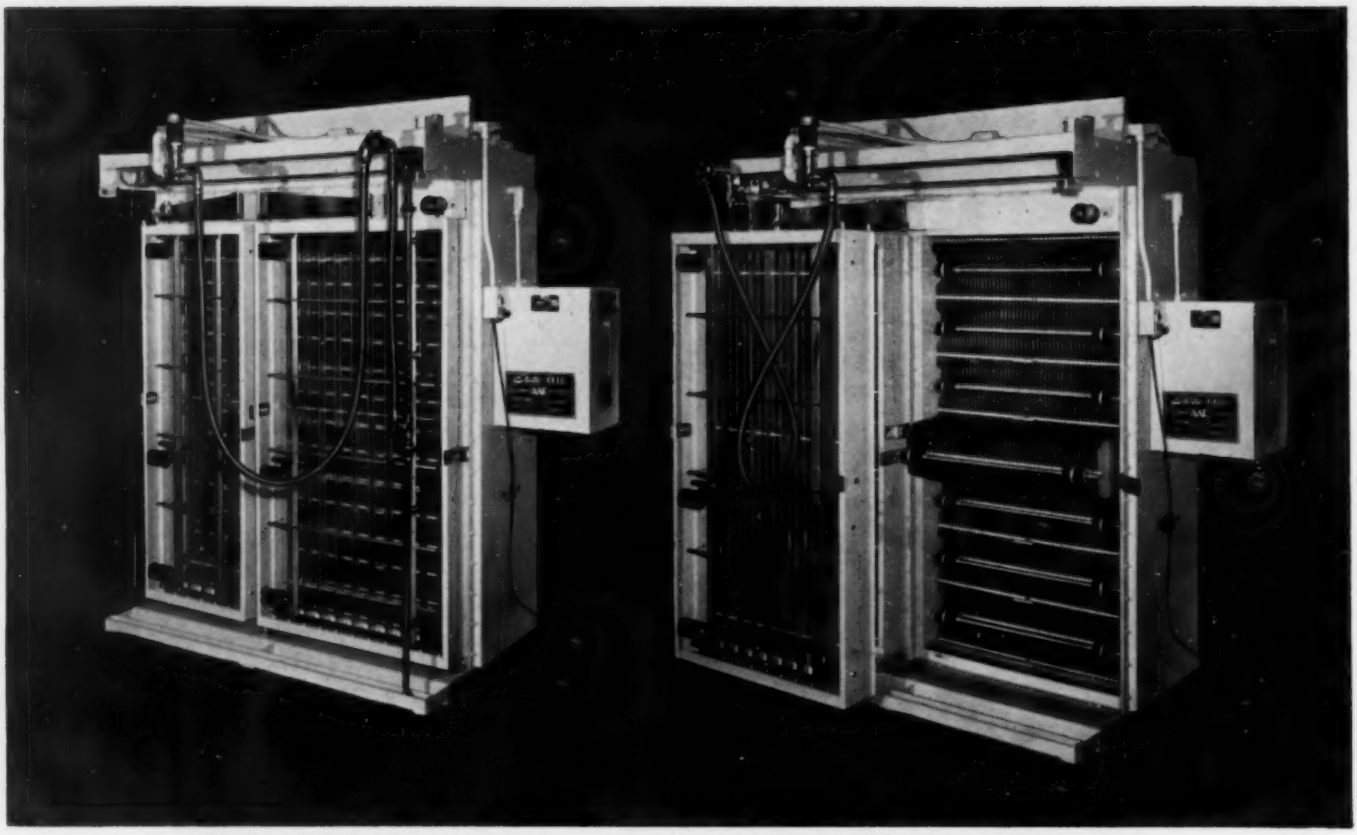
Other new developments include a new system for stacking and storing semi-finished steel.

Two 4,000,000-gal oil storage tanks have been erected which hold oil in reserve for use during emergency fuel periods. Oil comes all the way from Texas or other southwest oil fields by river barge which are unloaded at Duquesne Works' new river dock, which was constructed in 1951.

On July 8, 1953, No. 3 blast furnace was put back in operation after it had been down for four months for repair and modernization. It is now one of the best equipped blast furnaces in United States Steel and has new electric precipitators which have been installed to clean the blast furnace gas.

Supplying air pressure for No. 3 blast furnace is a new 90,000 cfm turboblower. The new turboblower supplies as much wind to the blast furnaces as any three of the old steam engines which were installed in 1902.

New equipment was recently installed in the pump house which daily can supply Duquesne Works steelmaking facilities with 180,000,000 gal of water pumped from the Monongahela River.



The Type "H" Washer incorporated as an integral part of an ELECTRO-CELL precipitator provides "push button" control of the cleaning operation. The washer travels on an overhead trackway which keeps it operating freely. The vertical header carrying the spray nozzle is rotated at each end of the travel to provide the necessary 5 degree lead to assure thorough cleaning of the plates. RIGHT: Shows how the hinged ionizers can be opened freely to permit removal or inspection of the plate cells.

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Here's another *first* from the engineering department of American Air Filter Company. The new Type "H" Washer on the famous ELECTRO-CELL precipitator is a major contribution to the field of electronic air cleaning equipment—another important reason for AAF leadership!

Fully automatic, the spray head moves back and forth across the face of the removable plate cells. Accumulated dirt and dust is washed away—maintaining the high cleaning efficiency of the ELECTRO-CELL . . . which provides super clean air for many critical industrial and commercial uses.

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Another exclusive feature of the new Type "H" Washer is the positioning of the spray-heads. These are automatically adjusted to always point at a 5 degree angle in the direction the spray-heads are travelling. This insures thorough washing action over the entire depth and each side of each individual plate.

The water used by the sprayer is controlled by a solenoid valve connected with the spray-head motor drive and is synchronized with the travelling spray-heads.

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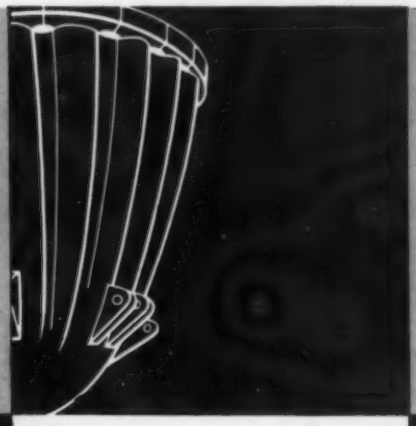

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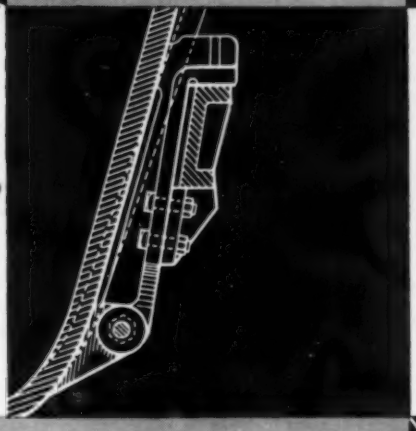

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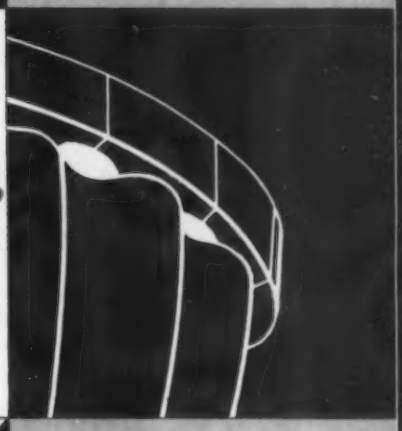

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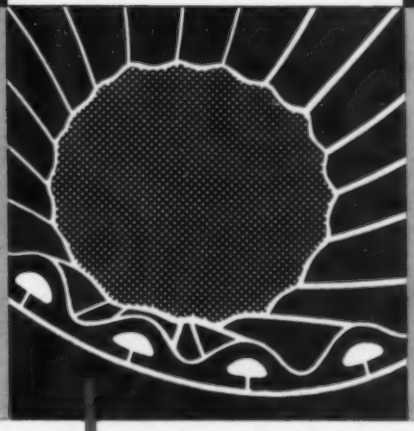

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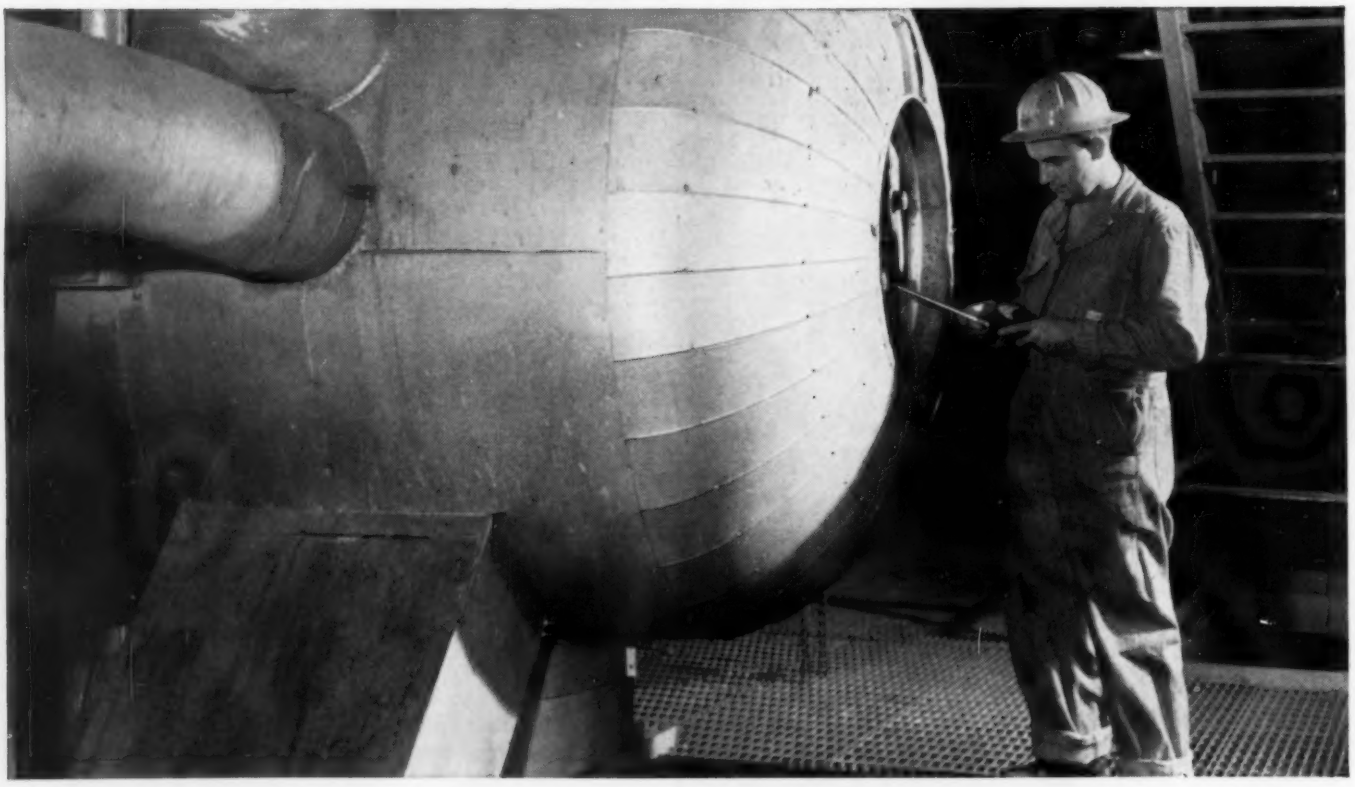

Perhaps the most convincing way of demonstrating the advantages of one method of cleaning over another is to conduct a comparative test.

That's exactly what one of the larger utility companies did to compare chemical cleaning with mechanical cleaning. The 23-day test was conducted with companion boilers, rated at 200,000 lb. per hour operating at 500 p.s.i. One boiler was chemically cleaned by Dowell, the other was turbined.

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Date-line Diary...

July 2

▲ Electricity output rose to a record 8,400,000,000 kw last week, up 15.4 per cent from the same period in 1952.

▲ Scrap prices moved up in the Pittsburgh district, reaching $45 a ton, a $2 increase.

▲ American Steel & Wire Div. of U. S. Steel estimates that over $20,000,000 will be spent on an expansion program in Cleveland. Program includes a combination rod and billet mill.

July 3

▲ The Aluminum Association announced a new monthly record in May for primary aluminum production with a total of 210,953,111 lb. This topped the previous record in March by 2,000,000 lb and was a 31 per cent increase over the 161,607,096 lb in May 1952. Shipments of sheet and strip in May totaled 122,756,743 lb.

▲ U. S. Steel Corp. announced that operation of sheet and tin mill finishing equipment will begin at its Fairless Works by the third quarter of this year. Mill base prices were established on these products.

▲ U. S. Steel Corp. announced it will stop operations at its Isabella furnaces at Etna, Pa. about the first of August. Plant has been in operation for 83 years.

▲ Installment credit was over $20,000,000,000 at the end of May, a record high.

July 6

▲ The AISI reports that operating rate of the steel industry for the coming week is scheduled at 94.6 per cent of capacity. This is equivalent to 2,132,000 tons compared with 2,069,000 tons one week ago.

▲ Great Britain plans to sell about 75,000 tons of copper held by the Ministry of Materials. Quotations are expected to be close to 30¢ a ton.

July 7

▲ The United States plans to purchase Bolivian tin concentrates on a one-year contract to help loosen the serious economic status in Bolivia. In previous years the United States has used 14,000 to 17,000 tons annually.

▲ The McLouth Steel Corp. announced plans for financing a $105,000,000 program which will double its current output. Program will make company an integrated producer.

▲ Construction expenditures for the first half of this year climbed to a record of $16,000,000,000, up 8 per cent from a year ago.

July 8

▲ According to the AISI, employment in the iron and steel industry in May reached a new high estimated at 685,300. The average hourly wage rose to $2.222, the highest ever reached, and average work week was 39.9 hr. Total payroll was $280,953,000.

▲ Employment in June increased to 63,172,000, up 1,500,000 over the previous month according to the Commerce Department.

▲ The Donora works of U. S. Steel Corp. will temporarily close its No. 1 blast furnace for relining.

▲ Production of goods and services in the second quarter rose to a record annual rate of $368,000,000,000.

▲ Commerce Department announced that inventories held by manufacturing wholesale and retail firms on May 31 totaled $78,000,000,000, up $4,000,000,000 from a year ago.

▲ Senator Capehart introduced a bill which will allow five year amortization of any capital investment in land, building, machinery, or equipment after December 31.

July 9

▲ After a hold-up of several weeks, the House Ways and Means Committee approved the bill to extend excess profits through December 31.

▲ The O.D.M. authorized Bethlehem Steel Co. to write-off 50 to 85 per cent of various portions of $38,750,000 over a 5-year period. About $30,000,000 of this will be used for a wide flange structural mill at Bethlehem.

July 10

▲ Phelps Dodge Corp. reduced price of copper wire and cable by 1.57¢ to 2.1¢ a lb.

▲ The ARCI announced new domestic freight car deliveries for June totaled 6463 compared with 6582 in May and 6411 for June one year ago. New orders in June totaled 1463 cars. Backlog as of July 1 was 52,315.

▲ Portsmouth Steel Corp. applied to SEC for permission to buy 85,004 shares of Cleveland-Cliffs Iron Co. stock from Alleghany Corp.

July 11

▲ U. S. Steel Corp. shut down their No. 5 blast furnace at Duquesne for relining.

July 13

▲ Commerce Dept. reports that the annual rate for personal income for May increased $1,000,000,000 over the previous month to $284,000,000,000.

▲ The AISI reports that operating rate of the steel industry for the coming week is scheduled at 96.2 per cent of capacity. This is equivalent to 2,169,000 tons compared with 2,092,000 tons one week ago.

July 14

▲ Britain's iron and steel industry was put up for sale to private owners after two years ownership by the government.

▲ Republic Steel Corp. reported record sales for the first 6 months of 1953. Net profits rose to $4.72 a share for the half year on sales of $602,000,000. This compares with net income of $2.61 for the same period last year.

July 15

▲ Alcoa boosted its price for aluminum ingots by 1¢ to 21½¢ a lb. Pig went from 19½¢ to 20¢.

▲ Ohio Valley Electric Corp. is financing a $420,000,000 project to supply power for an atomic energy plant to be built near Portsmouth, Ohio.

▲ U. S. Steel Corp.'s Youngstown plant renewed operations of their No. 4 blast furnace which had been out for one month for repairs.

July 16

▲ The March quarter profits for manufacturing firms showed an 11 per cent increase over the same period one year ago.

▲ U. S. Steel Corp. has a 49 per cent interest in a French firm, Comilog which has discovered a large deposit of about 50,000,000 tons of manganese ore in French Equatorial Africa.

▲ General Electric Co. announced record sales for the first 6 months of 1953 at $1,560,448,000, an increase of 33 per cent over the same period the previous year. Profits were $2.61 a share compared with $1.98 the previous year.

July 18

▲ The American Smelting & Refining Co. announced a switch in the pricing system, going from the basing point system to a delivered base price for prime western grade zinc.

▲ F. W. Dodge Corp. announced contracts for June totaled $1,210,509,000 in the 37 eastern states. This is 25 per cent less than May and 19 per cent less than June 1952.

July 20

▲ The AISI reports that operating rate of the steel industry for the coming week is scheduled at 96.8 per cent of capacity. This is equivalent to 2,183,000 tons compared with 2,134,000 tons one week ago.

July 21

▲ The Commerce Dept. reported output of major consumers durable goods for the first half of 1953 was 40 per cent higher than the same period in 1952.

▲ The Senate voted to replace Reconstruction Finance Corp. and the Small Defense Plants Administration by a new lending agency called the Small Business Administration.

▲ The Government asked U. S. District Court in N. Y. to cancel a contract by Alcoa to buy 1,200,000,000 lb of aluminum from Aluminum Ltd. of Canada, stating that this contract gives Alcoa competitive advantages in holding its position in the industry.

▲ The House passed a bill to continue the one year suspension of import duties on all types of metal scrap except lead and zinc.

July 22

▲ The Commerce Department reported a decline in exports of $162,000,000 to $6,700,000,000 for the first 5 months of 1953.

▲ The Commerce Dept. reported that national production of goods and services for 1952 reached a new high of $348,000,000,000, 5½ per cent over 1951. Price advances of 2½ per cent accounted for part of the rise in dollar volume.

July 23

▲ Pittsburgh Coke & Chemical Co. reports earnings of $1.76 a share for the first 6 months of 1953 as compared with 87¢ per share for the same period in 1952. Net sales for the first half of 1953 amounted to $28,135,000 which is an increase of 42 per cent over the same period in 1952.

▲ Colorado Fuel and Iron Corp. reported a net income for the fiscal year ending June 30 of $7,621,741 and $3.07 per share compared with $2.64 for the previous year. Total sales reached an all time high of $248,835,574.

July 24

▲ The Granite City Steel Co. reported earnings for the first half of 1953 at $1.96 a share or 350 per cent of the 56¢ per share earned in 1952 for the same period. Their total earnings of $3,188,000 is the greatest the company has earned in any half year period. Earnings in the first half of 1952 were $1,145,000.

▲ Brainard Steel Div. of Sharon Steel Corp. in Warren, Ohio aims to triple the firm's capacity for strappings by constructing a new steel strapping plant which will add 75,000 sq ft to present facilities.

▲ To prevent danger of shutdown, soft coal operators in the South proposed to cut labor costs and to reduce the 40-cent per ton contribution to United Mineworkers welfare fund.

July 27

▲ The AISC reports June shipments of fabricated structural steel amounted to 274,587 tons, the highest since July 1930. Bookings amounted to 232,441 tons during June, leaving a backlog of work on June 30 at 2,152,764 tons.

▲ The AISI reports that operating rate of the steel industry for the coming week is scheduled at 96.7 per cent of capacity. This is equivalent to 2,180,000 tons of steel compared with 2,128,000 tons one week ago.

July 28

▲ National Steel Corp. reports net earnings for the quarter ended June 30 at $12,989,799, equal to $1.77 per share as compared to the second quarter of 1952 with earnings of $6,774,124, equal to 92¢ per share. Six months earnings were $3.27 a share.

▲ Jones & Laughlin Steel Corp. announced a net income of $10,721,000 for the quarter ending June 30 which amounted to $1.67 a share for common stock. The same period for 1952 brought a loss of 8¢ a share. Six months earnings were $2.52 a share.

▲ Lukens Steel Co. reported a net income of $3,207,126 for the first three-quarters of its fiscal year, or $10.08 a share on capital stock. This compares with an income of $1,697,543 for the same period in 1952 equal to $5.34 a share.

▲ U. S. Steel Corp. reported income for the second quarter of 1953 of $55,640,806 and $105,016,764 for the first six months, or $3.54 a share compared with $2.04 a share for the same period one year ago.

▲ Acme Steel Co. reported sales for the first six months of $39,624,000 with a net income of $2,554,000 or $1.28 per share compared with $1.07 for the same period a year ago.

▲ Inland Steel Co. reported its sales, production, and shipments were the highest in its history. Net income for the first half was $15,677,521 or $3.20 a share compared with $2.32 for the same period in the previous year.

July 29

▲ West German steel production for the first six months totaled 7,746,000 tons compared with 7,302,000 the year before.

▲ The Agriculture Dept. reported that farm income dropped 5 per cent the first half to $12,600,000,000.

▲ Youngstown Sheet and Tube Co. reported net income for the first 6 months of $14,944,206 or $4.46 a share compared with $2.54 for the same period in the previous year.

July 30

▲ General Motors Corp. reported sales for the first half set a new record of $5,400,000,000 with net profits of $3.51 a share.

▲ Westinghouse Electric reported sales for the first half of $780,000,000 with a net profit of $2.19 a share. Sales set new records.

▲ The Dept. of Commerce reports total exports of steel products for 1952 were 4,160,000 tons or 27 per cent over the previous year.

▲ Crucible Steel Co. reported net income, after taxes, for the second quarter of 1953 at 2,165,641 or $2.71 a share compared with 5¢ a share for the same period a year ago.

July 31

▲ ICC extended 15 per cent freight rate increase an additional 22 months until December 31, 1955.

▲ Bethlehem Steel Corp. reports net profits for the first 6 months of $59,495,136 on net billings of $1,056,293,226. Earnings per share for the first 6 months were $5.87 compared with $2.19 for the same period in 1952.

▲ Alan Wood Steel Co. announced that they plan a cold rolled strip mill at an estimated cost of $6,000,000 to be located at Ivy Rock, Pa. Work should be completed by the first quarter of 1955.

READY FOR RUGGED DUTY

Maxi-Power Drive assembly for overseas cement mill. This unit, on a special base, has long input and output shafts supported by outboard bearings. The large spur pinion will drive a 20-foot, 18-inch face spur gear.

FOOTE BROS. MAXI-POWER DRIVES

With maximum load-carrying capacity for day-after-day service, Foote Bros. Maxi-Power Drives offer a ready solution for toughest speed reduction applications.

Sturdy, compact Maxi-Power Drives have precision-generated helical gearing — uniform load distribution across the entire tooth surface. Maximum performance is assured for all applications where rugged service is required.

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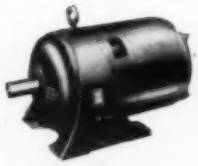
Foote Bros. also offers a complete line of foot or flange mounted drives for both horizontal and vertical applications, and Foote Bros.-Louis Allis Gearmotors, horizontal and vertical.

This Trademark Stands for the Finest in Industrial Gearing

Line-O-Power Drives



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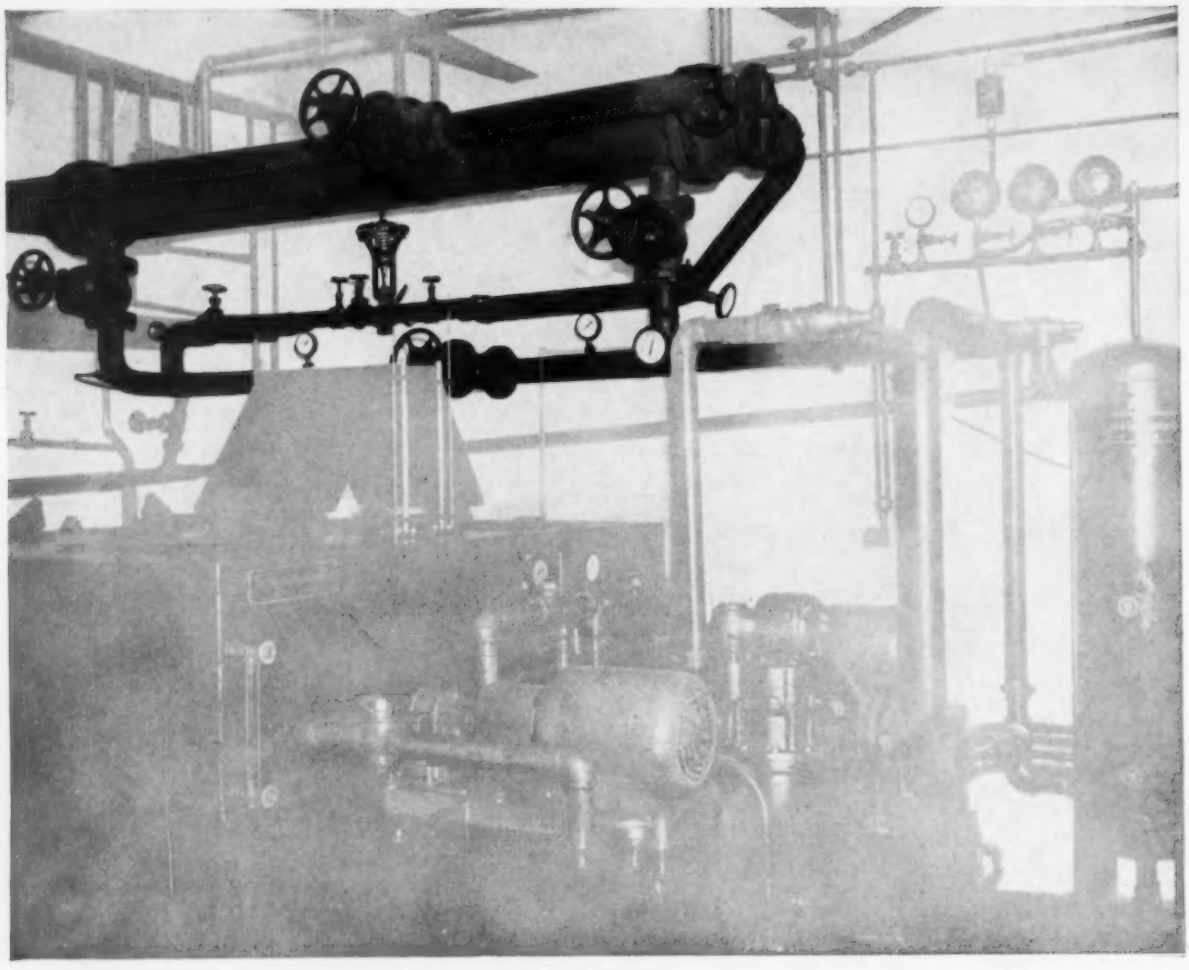

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Efficient temperature control requires efficient heat exchangers. De Laval Mill Lubrication Systems use Ross Heat Exchangers, which are carefully rated for performance beyond specified conditions. Compact in design, relatively light in weight, easily installed and reliable, these Ross Heat Exchangers have a well-established reputation for long life and minimum maintenance.

De Laval engineers insist that every piece of auxiliary equipment used either in their custom-built or self-contained Unilube systems should be of top-flight quality. De Laval's attention to such details makes the difference between a system that gives no trouble at all and one that is a constant source of worry.

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ENGINEERED SYSTEMS

Amsco Chains Get Tougher With Use

How AMSCO Manganese Steel Chains Acquire Progressively Greater Resistance to Impact and Abrasion.

Actual case histories prove that AMSCO Manganese Chains outlast ordinary chains by more than 6 to 1 where impact and abrasion exist. For example, on one conveyor operation, ordinary chain had to be completely replaced every three months. When AMSCO Manganese Steel Chain was installed, only a small fraction of the links were replaced during a test period of over 24 months.

Users of AMSCO Chains benefit by unusual freedom from expensive chain replacement, breakage, maintenance-down-time and other problems caused by impact and abrasion conditions.

AMSCO Manganese Steel Chains have the unique ability to work-harden with use. In rough service, they develop a surface hardness up to 500 Brinell. They also acquire a hard glass-like polish that helps shrug off grinding abrasion. All AMSCO Manganese Steel products — tough when produced — possess the extra-value quality of actually increasing durability with in-use battering and grinding.

AMSCO Chains are made of Manganese Steel —the "Toughest Steel Known." They are produced in many standard and special shapes by American Manganese Steel Division—largest producer of manganese steel for all industry.

If you use chain, and desire a more durable alloy, you are invited to contact AMSCO. There's a good chance we can save you money and provide chains that will outlast your service life expectations.

Drag Line Type Chain—Mining & Excavating
AMSCO Chain Assumes Many Forms To Serve Industry. A Few Are:
Detachable Chain—Bucket Elevating
Pinlock Type with Cast-on Dog—Log Hauling
840 Series Chain—Bucket Elevating
Rivetless Chain—Mining
Clinker Drag Chain—Cement Milling

AMERICAN Brake Shoe COMPANY

AMERICAN MANGANESE STEEL DIVISION

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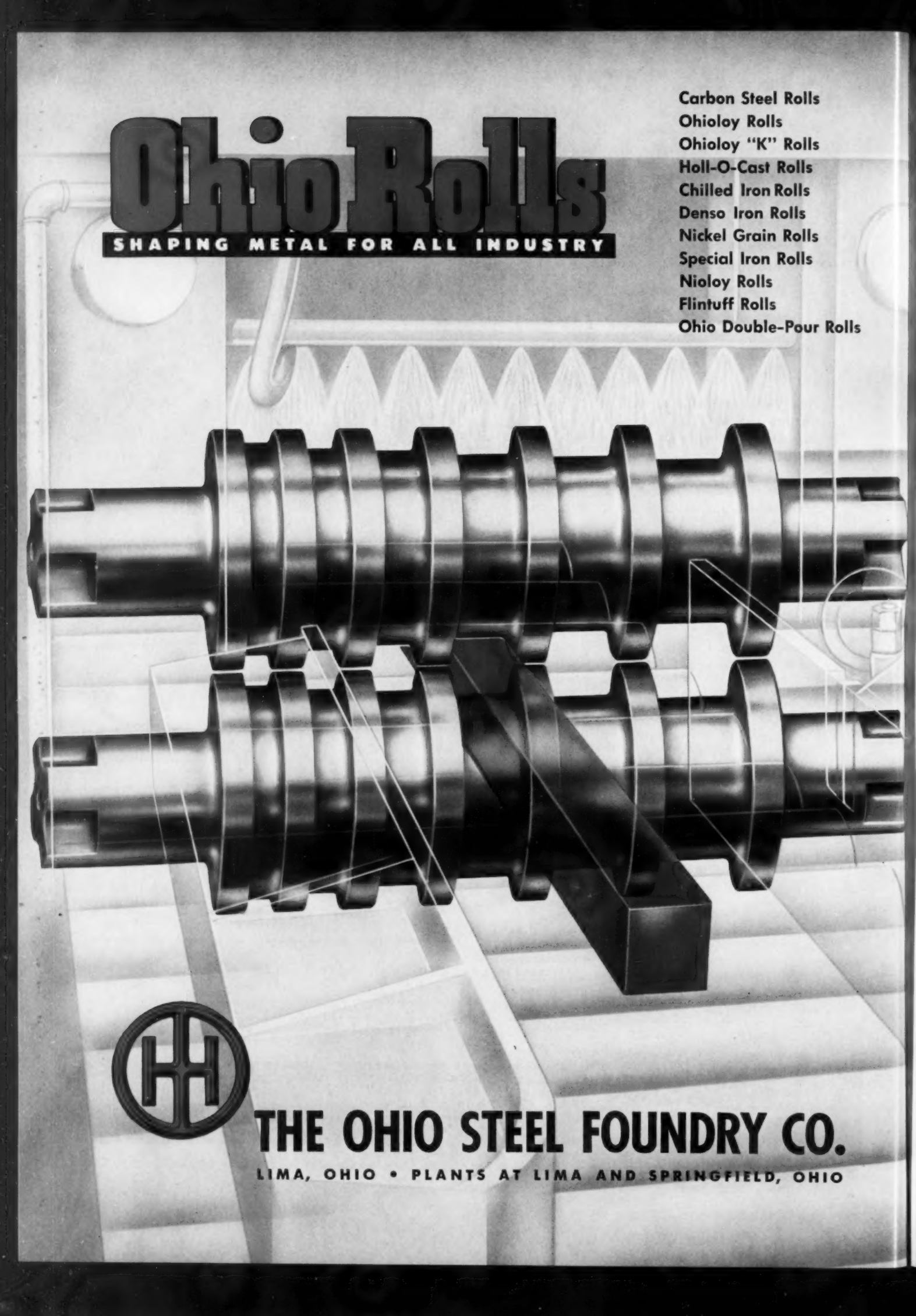
Other Plants: New Castle, Del., Denver, Oakland, Cal., Los Angeles, St. Louis. In Canada: Joliette Steel Division, Joliette, Que.
Amsco Welding Products distributed in Canada by Canadian Liquid Air Co., Ltd.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Industry News...

REBUILT BLAST FURNACE NO. 3 BEGINS TENTH CAMPAIGN AT DUQUESNE WORKS

▲ United States Steel's Duquesne, Pa., Works placed No. 3 blast furnace back into service for her tenth campaign on July 10. The furnace has a daily rated capacity of 931 tons and was out of operation since February 27 for relining and modernization.

No. 3 has been completely equipped with electrical controls which automatically charge the tall stack with ironmaking ingredients in proper proportions at correct intervals. In addition to the automatic charging controls, other modernization work included the installation of an electric precipitator to clean the gas for the furnace stoves. Also four stoves serving No. 3 blast furnace were relined. Other equipment completely replaced was the skip bucket with a charging car, the bell operating mechanism, and the coke handling and weighing equipment. Installation of a new furnace top added 20 ft to the height of the structure, which is now 149 ft.

R. W. Graham, general superintendent of Duquesne works, pointed out that changes to the inside of the furnace have prepared No. 3 to play a "dual role" in steelmaking at Duquesne. He pointed out that nine rows of cooling plates, together with new water sprays, have been installed in the furnace to withstand exceptionally high temperatures so that the furnace can produce ferro-manganese as well as iron.

A new turbo blower, installed recently, will supply the furnace with 90,000 cu ft of air volume per minute.

During the ninth campaign, which started April 8, 1942, No. 3 produced 3,065,000 tons of basic iron. Most of this furnace was rebuilt in 1924 and originally dates back prior to 1901—over a half century on the production line.

OLD TIMER AT DUQUESNE WORKS TO BE RETIRED

One of the oldest ore bridges in the country will soon be replaced after completing 46 years of service. This bridge, the first man-trolley ore bridge ever built by Heyl & Patterson, Inc., has been operating at the Duquesne Pa., works of the United States Steel Corp. since 1907. Within the next few months this 10-ton-capacity veteran will be dismantled and replaced by a new 15-ton capacity bridge, again designed, fabricated and erected by Heyl & Patterson, Inc.

MOVE KANSAS STEAM PLANT TO COLORADO

▲ A mammoth 100,000 lb-per-hr steam plant has been sliced into sections, loaded on railroad cars in Kansas, and successfully "transplanted" to the Pueblo, Colo. steel mill of Colorado Fuel and Iron Corp., 500 miles away.

The novel moving job was performed in 17 weeks by teams of technical specialists and skilled craftsmen. The Pueblo steel mill's steam generating system was completely rebuilt without a shutdown.

Big steam boilers have to be especially built for the job, and it takes about a year to build one. CF&I engineers canvassed the U. S. power industry to find one that could be converted for use in the Pueblo mill in a matter of weeks, so as to have ample power ready for the new seamless tube mill now being rushed to completion. They found one in an idle Sinclair refinery in Coffeyville, Kan. —a Walsh-Weidner sectional-head boiler. This unit was ideal because it could be dismantled immediately, was located close to a railroad, and was in "like new" condition.

The big boiler was cut into movable sections with acetylene torches, and the trip was made to Pueblo on five railroad cars. Transplanting of the jig-sawed boiler was accomplished without difficulty, 17 weeks later, it was cut into the Pueblo plant system. It is now carrying its share of the total load, while two new 100,000 lb-per-hr boilers are being installed. All three boilers will be in operation by October, plant engineers estimate.

BEGIN CONSTRUCTION ON ASSEMBLY BUILDING

▲ Northern Engineering Works, Detroit, Mich., manufacturers since 1899 of overhead electric traveling cranes and other material handling equipment, announced that construction of a new 20,000 sq ft assembly build-

THE DIAMOND "UTILISCOPE"
(WIRED TELEVISION)

An employee who...

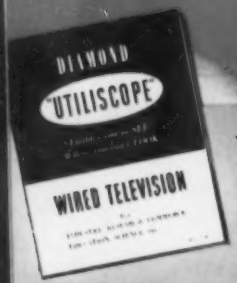
Requires no pay check
Never makes a mistake
Works 24 hours a day
Never takes a vacation

Many industrial operations that must be watched continuously and formerly required the individual attention of a man, are now being done without the man . . . by using a Diamond "Utiliscope" (Wired Television). The camera takes the place of the man . . . the monitor or receiver brings an exact picture of what is happening (as it happens) to a remote central control point or wherever else desired.

The "Utiliscope" is surprisingly low in cost. Its image is always clear and stable—it cannot transmit an incorrect image. It is on the job 24 hours a day, day in and day out, with practically no attention. The "Utiliscope" has no human limitations.

Let us tell you how the "Utiliscope" is now saving manpower, improving product quality, increasing production or preventing accidents. There probably is an application you can use to advantage. Write for Bulletin.

TYPICAL USES—Checking remote gauge readings • Watching flow of molten steel • Viewing nuclear research • Observing conditions inside furnaces • Coordinating materials flow on conveyors. • "Utiliscope" (Reg. U.S. Pat. Office)



WRITE FOR BULLETIN 1136-E

DIAMOND POWER SPECIALTY CORP.
FIRST IN INDUSTRIAL TELEVISION
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Diamond Specialty Limited—Windsor, Ontario
Since 1903, Diamond has Manufactured Quality Equipment For Industry

ing has been started to provide more efficient handling of heavier capacity, longer span cranes.

The company is also modernizing and expanding its fabricating facilities throughout the plant.

This new addition, scheduled for completion by September 1, 1953, will permit this larger, heavier construction with a minimum of handling during assembly.

PRODUCTION RECORD ANNOUNCED BY KAISER

▲ Kaiser Steel Corp. annuonced record production of 770,000 net tons of steel ingots for the six months ended June 30th. This exceeded by 10.6 per cent the record for any previous six months period.

Monthly production of steel ingots in the open hearth department has continued to set new records since January, the start of operations of the ninth open hearth furnace. The month of May marked an all-time high as production rose to 135,000 net tons of steel ingots, representing operations at 105.6 per cent of rated capacity for the nine furnaces.

Rolled and tubular products produced at the Fontana, Calif. mill reflected a 7 per cent increase over the record for any six month period. New monthly production records were established in the electric resistance weld pipe mill, blooming mill, plate mill and hot rolled sheet mill.

To meet the increased production at the mill, record output at the Sunnyside, Utah coal mines, and the Eagle Mountain, Calif., iron ore mines has been accomplished. Iron ore shipments to Fontana are approximately 90 cars per day, and coal shipments approximately 75 carloads per day.

DONORA BLAST FURNACE BACK IN PRODUCTION

▲ It is believed by U. S. Steel Corp. that a record time for relining a blast furnace stack was established at 3:00 p.m. July 20 when U. S. Steel's Donora, Pa. American Steel & Wire works relit No. 1 blast furnace 15 days, 10½ hours after starting repairs.

Umberto F. Corsini, general superintendent of this American Steel & Wire Division plant, in making the announcement said the furnace was

Umberto F. Corsini (right), general superintendent, Donora Works of U. S. Steel's American Steel & Wire Division, and John M. Merrit (left), keeper of No. 1 blast furnace thrust blow pipe bar through tuyere to relight the big stack. The furnace was back in production following a record time relining from the mantle up.

taken out of production at 6:21 a.m. July 5 and completely relined from the mantle up. Best previous known time for a similar relining is 19 days.

A basic iron producer for more than half a century, No. 1 begins her 13th campaign. Her last campaign, which began January 13, 1949, following a complete rebuilding, produced 1,041,209 net tons of iron. The daily rated production capacity of No. 1 blast furnace is 652 tons.

ESTABLISH THREE NEW BRANCH WAREHOUSES

▲ Nelson Stud Welding Division of Gregory Industries, Inc., has announced the establishment of three new direct factory branch warehouses at Atlanta, Ga., St. Louis, Mo., and Denver, Colo., to provide direct service to the increasing number of manufacturing, railroad and construction firms using stud welding in these areas. All will stock studs, parts and accessories and will have Nelson stud welding guns, Nelwelder generators and battery units which will be available for purchase or rental.

All three warehouses will also handle Remington stud driver and studs for which the Nelson organization is a national distributor.

Herbert W. Scott, Jr., southeastern district manager, will be in charge at 696 Whitehall Street, Atlanta, where Fred Millenbaugh, head of Nelson's customer service department at Lorain, Ohio headquarters for the past seven years, has been assigned as field engineer for the states of Georgia and South Carolina.

Donald Duffey heads up the St. Louis territory, which will be served from a factory branch warehouse at 1937 South Vandeventer Street.

Vincent G. Probst will be in charge of the Denver factory branch at 1416 Blake Street.

J & L OPENS NASHVILLE SERVICE WAREHOUSE

▲ Quicker steel delivery service to metalworking plants in central Tennessee were made possible when Jones & Laughlin Steel Corp. opened its new Nashville, Tenn., warehouse on July 15.

IS HEAT SLOWING UP YOUR WORKMEN?

TRUFLO CRANE CAB FANS
For cooling interiors of crane cabs and other confined areas. Adjustable both horizontally and vertically. Four blade type, 12 and 18 in. sizes.

Keep them COOL with TRUFLO FANS

TRUFLO PORTABLE COOLING FANS
Easily portable. Help keep efficiency high where work is hottest. 12 to 36 inch diameters.

Production suffers when workmen are overheated. Steps begin to drag, efficiency falls.

Now, when speedy production is vital, Truflo Fans can help keep your workmen on their toes. All Truflo Fans are designed and built correctly to put fresh cool air *in large volumes* exactly where it is needed. Perfectly-balanced shafts and blades give more air per h.p. . . . strong steel frames stand up longer under hard use . . . rugged wire guards protect men against injuries.

All of the following types can help beat the heat, keep production moving in your plant. Write for illustrated literature.

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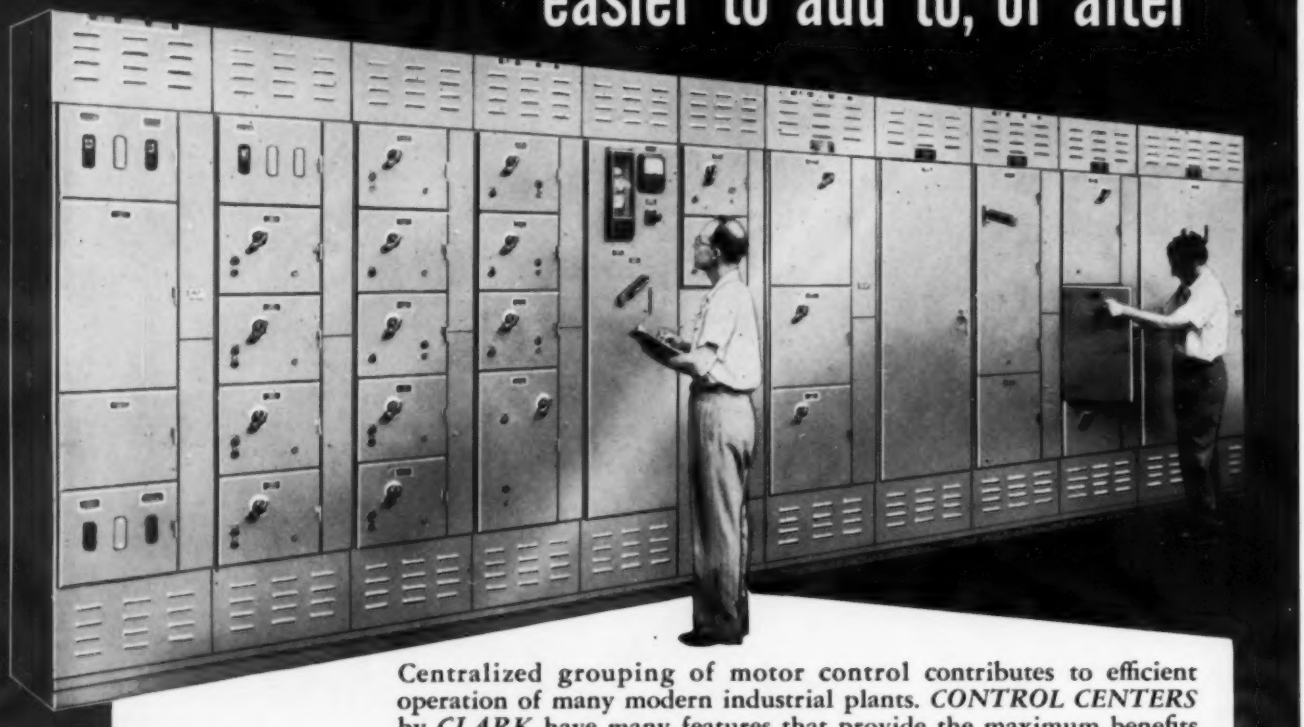
are *easier to install* ... easier to service ... easier to add to, or alter



Centralized grouping of motor control contributes to efficient operation of many modern industrial plants. *CONTROL CENTERS* by *CLARK* have many features that provide the maximum benefits obtainable. For example:

Separately enclosed 6-inch wide vertical wireways for each vertical section are accessible without opening compartment doors. This feature means easier installation and maintenance.

Safe-edge compartment doors eliminate dangerous sharp edges and corners. Door handles are interlocked with disconnect switches or circuit breakers.

Frame is rigidly constructed in double-box style, of sturdy welded channel sections, capable of withstanding heavy blows without destroying alignment.

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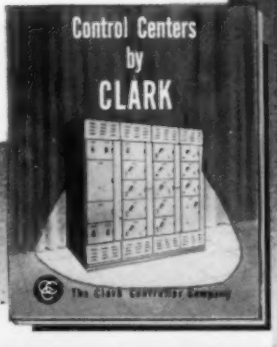
Each compartment is an integral unit, independent from frame and, in practically all sizes, is completely removable, with plug-in connections. This provides maximum flexibility.

Uniform neat appearance of compartments, in a complete range of sizes, permits an almost infinite variety of combinations.

In NEMA Type C construction, Clark Control Centers permit terminals to be located in top and/or bottom or in vertical wireways.

The use of standard factory-assembled components throughout eliminates special engineering, saves time and money in installations.



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Send request on your company letterhead for your copy of this factual book, now in preparation.

ENGINEERED ELECTRICAL CONTROL

THE CLARK CONTROLLER CO.

1146 EAST 152ND STREET, CLEVELAND 10, OHIO

Jones & Laughlin is the first major steel producer to open a warehouse in Tennessee's capital.

In the past, the small industries of the Nashville region have obtained their steel from warehouses in Chattanooga, 138 truck miles away, or from Memphis, 224 miles away, or even from more distant cities.

The larger steel buyers — when they could afford to wait for slower water shipments—have been buying by the barge load. There is a 193 mile haul on the Cumberland River from the Ohio to Nashville's municipal dock. When in a hurry, their deliveries have come by rail.

INCREASE ANNEALING PRODUCTION AT PUEBLO

▲ New annealing equipment has been installed at Colorado Fuel and Iron Corp.'s fully-integrated steel mill at Pueblo, Colo. This equipment will double the plant's capacity for the production of pot annealed wire, according to A. F. Franz, president of the corporation.

New annealers will supply wire to additional coiling equipment for final processing into standard 48-lb and 100-lb coils of automatic baling machine wire. In cooperation with equipment manufacturers and the American Society of Agricultural Engineers, baling wire coils have been standardized at 14½ gage with coil lengths of 3,150 and 6,500 ft.

This standardization has made it possible to use modern packaging techniques, boxing and baling wire for shipment in standard-size, easy-to-handle cardboard cartons. The overall increase in production that has been accomplished by the new equipment and improved methods will result in speeded-up delivery of this product to widespread farm markets.

H. K. PORTER CO. ACQUIRES ROPE FIRM

▲ H. K. Porter Co., Inc., Pittsburgh, Pa., acquired a controlling interest in A. Leschen & Sons Rope Co., St. Louis, Mo.

Leschen Co., established in 1857, is one of the country's oldest producers of wire rope. The company supplies wire rope for oil and gas drilling, elevators, marine uses, der-

..and on
run-out tables,
too...
LOVEJOY L-R
FLEXIBLE COUPLINGS
last longer.... do the
job better!
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MAINTENANCE-FREE
SERVICE RECORDS
"...three years of continuous operation of our run-out tables and not a single shut-down or break-down due to coupling failure". This statement is typical of the many made about the performance of Lovejoy Flexible Couplings. They have free-floating load cushions suspended between heavy metal jaws and cushions last two to five years. No shut-downs for changing cushions. These couplings instantly correct for mis-alignment without vibration, backlash or surge. No lubrication ever needed. For maintenance-free operation of your run-out tables and other equipment, use Lovejoy Flexible Couplings.
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CRANEPHONES
provide low cost
COMMUNICATION
THROUGHOUT HEAVY INDUSTRY

Efficiency is improved—production goes up, when Femco equipment is installed. With Cranephones, you can talk from cab to floor, to office, and from cab to cab.

Other Femco Products of Merit include:

Femco AUDIOPHONES

Fixed-point industrial communication

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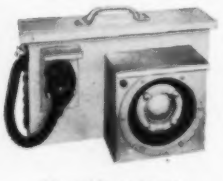

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- Easy to BUY or LEASE Easy to INSTALL and USE
- DEMONSTRATIONS ARRANGED

FARMERS ENGINEERING & MANUFACTURING COMPANY
IRWIN, PENNSYLVANIA

Ask for YOUR Femco Data Kit

Specialists in Electronic Communication and Control

ricks and cranes, bridges, water well and blast hole drilling, rope slings, and many other purposes. Operations will continue as Leschen Wire Rope Co., a division of H. K. Porter Company, Inc., under the direction of D. W. Vernon, Vice President and General Manager. A. A. Leschen, former president, has expressed a desire to retire from active business.

WESTINGHOUSE SELLS INDUCTION HEATING UNIT

▲The sale of equipment for induction heating of shells prior to forging at the U. S. Hoffman Machinery Co.'s Scranton, Pa., division has been announced by the Westinghouse Electric Corp.

The installation, the largest of its kind in the United States, will be supplied with 960-cycle power for induction heating of 8-in. and 155-mm shells by four 1250-kw high-frequency motor-generators. All four motor-generators will be parallel fed into a main bus, which will feed 14 dual position forge heating stations.

High-frequency circuit breakers will be used to give the installation complete protection against short circuits in the main distribution bus.

George J. Hagan Co., Pittsburgh, Pa., has been awarded orders to furnish the forging furnaces for U. S. Hoffman Machinery Corp.'s huge shell plant in Scranton, Pa.

Complement of the equipment to be furnished included two 30 ft rotary hearth furnaces, four 26 ft rotary hearth furnaces and four manipulators. Labor from the Scranton area is being used on the installation of this equipment.

ANNOUNCE CHANGES IN OFFICE LOCATION

▲ Effective July 18, 1953, the general office of United States Pipe and Foundry Co. was removed from East Pearl Street, Burlington, N. J., to 3300 First Avenue, North Birmingham 2, Ala.

Effective August 1, 1953, the Sloss-Sheffield Steel & Iron division of the company was consolidated with the general office departments in Birmingham and will no longer operate as a separate division.

The Philadelphia, Pa., sales office

will be removed to the former general office building at Burlington, N. J., and will be consolidated there with the eastern sales office.

FERROMANGANESE PLANT CAPACITY TO BE DOUBLED

▲ Electro Metallurgical Co. will have new facilities in operation at its plant in Alloy, W. Va., which will double the company's capacity for producing medium-carbon ferromanganese. This new furnace capacity is expected to be sufficient to meet the steadily increasing demand for this special grade of ferromanganese.

The alloy is widely used for the economical production of high-quality steels having good surface characteristics. Low-carbon rimming steels such as those used by the automotive and appliance industries are significant examples.

Medium-carbon ferromanganese contains 1.25 to 1.50 per cent carbon and is used in making steels having carbon specifications too low to permit the use of standard ferromanganese, but which do not require the use of low-carbon ferromanganese. When this alloy is used in the production of low-carbon steel, it is not necessary to reduce the carbon in the bath to the extent required when standard ferromanganese is used. Therefore oxidation of the bath is much less severe, and furnace time is saved.

POOLE FOUNDRY APPOINTS WISCONSIN AGENT

▲ Poole Foundry & Machine Co. announces the appointment of Kramer Industrial Sales Co., 312 E. Wisconsin Ave., Milwaukee 2, Wisc., as their representative in the state of Wisconsin and the east portion of Iowa for Poole flexible shaft couplings.

BEGIN CONSTRUCTION ON NEW RESEARCH UNIT

▲ A group of 200 Monroeville businessmen and civic leaders and United States Steel officials attended groundbreaking ceremonies for United States Steel's new research and development laboratory at Monroe-

HOW TO SOLVE HOT SPOTS

(UP TO 2200° F)

in products and processes

If improvement of your product or process depends upon use of extremely high temperature, while minimizing its destructive effects, use Kentanium at the critical points.

WHAT is Kentanium?

Chiefly titanium carbide (and small percentages of other refractory metal carbides), with nickel "binder". Uses neither tungsten nor cobalt. Hardness: Up to 93 RA. Weight: ⅗ that of steel.

WHAT can it do?

Resist thermal shock, withstand oxidation and abrasion, retain great strength at high temperatures (1800°F and above).

WHERE is it in use?

Successful applications include: Valves, valve seats, reduction crucibles, anvils for spot welding, hot extrusion die inserts, bushings, thermocouple protection tubes, flame tubes, furnace tong tips, balls for hot hardness testing, nozzle vanes and blades for jet engines, and many others.

WHAT forms are made?

Tubes, rods, bars, flats by extrusion process. More complex parts by machining from pressed slugs before sintering; extremely accurate parts by grinding to required tolerance after furnace sintering.

HOW can you use it?

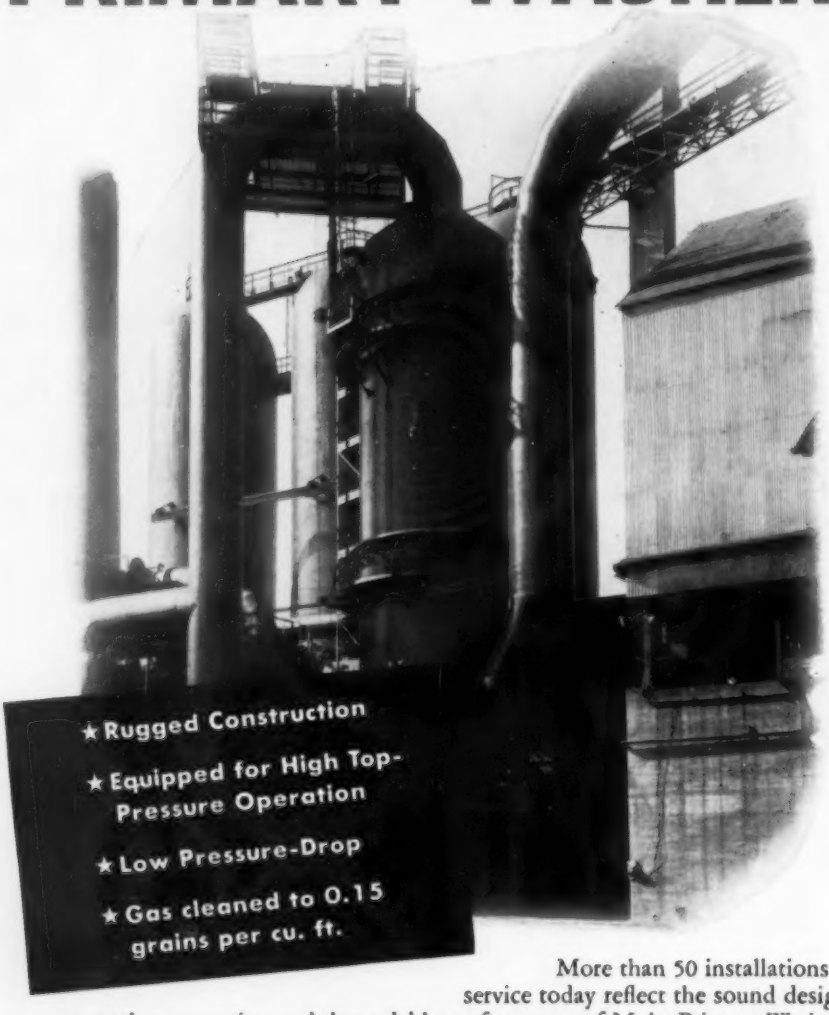
This remarkable new metal, available in many "grades" to meet specific combinations of imposed conditions, can best be adapted to your high temperature problem by cooperative effort. Our engineers will be glad to discuss how you can get best results from Kentanium.

An Exclusive Development of KENNAMETAL® Inc., Latrobe, Pa.

KENTANIUM

HEAT-RESISTANT, HIGH-STRENGTH, LIGHTWEIGHT CEMENTED TITANIUM CARBIDE

MOHR
PRIMARY WASHERS



★ Rugged Construction

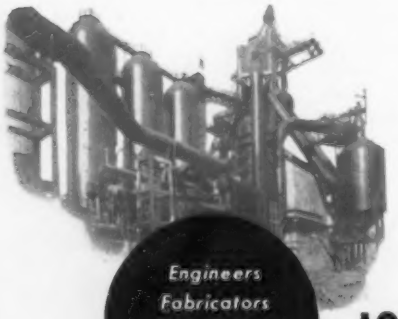
★ Equipped for High Top-Pressure Operation

★ Low Pressure-Drop

★ Gas cleaned to 0.15 grains per cu. ft.

More than 50 installations in service today reflect the sound design, rugged construction and dependable performance of Mohr Primary Washers. In this development, Mohr pioneered the use of acid-proof tile. Through use of various combinations of tile and sprays, the washer makes it possible to primary-clean practically any gas down to 0.15 grains per cu. ft. while the pressure drop through the washer is kept to less than 7 inches of water. Typical of the rugged construction, heavy steel gratings above and below the tile banks prevent furnace slips from displacing tile. Because of this, the washer is amply equipped to withstand high top-pressure blast furnace operation. Self-cleaning nozzle sprays can be provided with Mohr washers, and if the gas is particularly difficult to clean, high-pressure fogging sprays, without moving parts, are available for more intimate mixing of gas and water.

Your inquiry is invited.



Engineers
Fabricators
Contractors
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JOHN MOHR & SONS

3200 East 96th Street, Chicago 17, Illinois

ville on July 29, Dr. E. C. Bain, vice president—research and technology, signaled the start of construction by turning the first spadeful of earth.

Following the ceremony, heavy earth-moving equipment went into operation to meet the tight construction schedule calling for completion of this modern research center by early 1955.

The new research center will consist of three buildings with a total floor area of about 132,000 sq ft. Experimental equipment will include apparatus for studying every phase of the making, shaping and processing of iron and steel from raw materials to finished products. Equipment will run from electron microscopes to pilot lines for tin plating, galvanizing and aluminum coating of metals.

COKE PRODUCTION INCREASED AT PUEBLO

▲The volume of chemical by-products produced by Colorado Fuel and Iron Corp. at its Pueblo, Colo. plant has greatly increased as coke production has been expanded to meet the requirements of mounting pig iron production.

Around 10,000 gal of benzol are now produced daily by intricate refining processes at Pueblo's by-product coke plant.

The Pueblo plant now has an annual capacity of over 1,200,000 tons of coke, of which a considerable part is used in the blast furnaces. Sales are also made to foundries and other consumers. Pueblo's four blast furnaces produce about one million tons of pig iron a year.

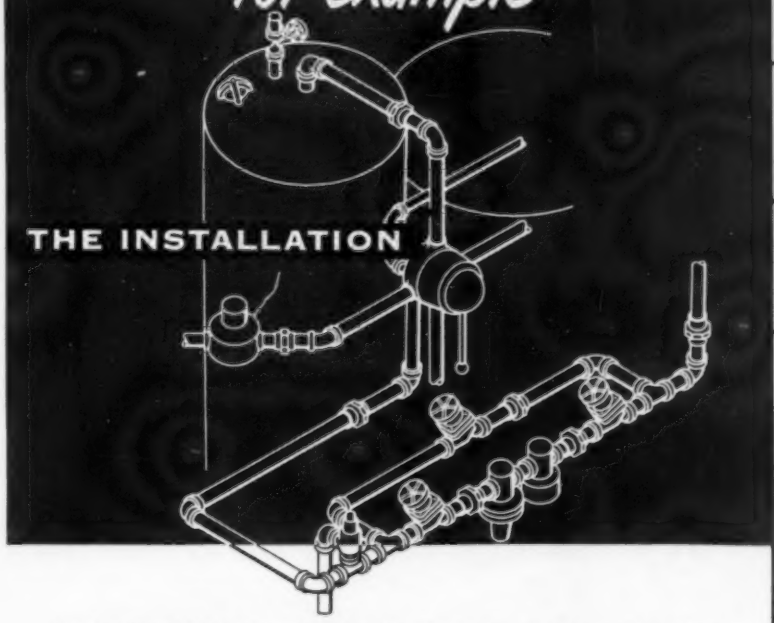
CONVERT OPEN HEARTH AT RIVER ROUGE PLANT

▲ Conversion of No. 10 open hearth to a new stationary hearth type furnace has been completed in the record time of 39 days at the River Rouge, Mich., plant of Ford Motor Co., according to Rust Furnace Co., the constructor.

With the rebuilding of No. 10 open hearth the last on the line at the Rouge plant has been converted from the old tilting type furnace to a new stationary hearth type of 400 tons capacity per heat.

This Valve Stops the "Up" in Upkeep ...on Water Service Piping,

for example



At the Excello Paper Products Co., Inc., Cincinnati, using Crane Diaphragm valves on city water supply lines; also on plant service water piping, hot and cold.

VALVE SERVICE RATINGS

SUITABILITY:	Doing what other valves couldn't
FEATURES:	Packless - Long Life Diaphragm
MAINTENANCE COST:	No regular maintenance needed
SERVICE LIFE:	Outlasting other valves many times
OPERATING RESULTS:	Safety hazard to personnel stopped
AVAILABILITY:	Crane catalog item - No. 1610

THE CASE HISTORY

Typical of many processes using a lot of water, this plant has numerous open end lines and hose connections. And because of very frequent operation, the valves formerly used in these lines required more than usual servicing to keep up with leakage, dripping hose lines, and hazardous, messy floors.

Crane No. 1610 Diaphragm valves were selected to replace the troublesome conventional valves. Immediately these packless valves stopped the annoyance and expense of stuffing box and seat leakage. Their pliable disc insert ring made a tight seat on open end lines with minimum effort on handwheels.

The replacements were started about 2 years ago. With no attention whatsoever, all Crane Diaphragm valves remain tight, and the plant's water leakage problem remains solved.

THE VALVE

Water is but one of hundreds of fluids Crane Packless Diaphragm valves handle efficiently. Their sealed-to-fluid bonnet and "soft-seating" disc are ideal for all sorts of hard-to-hold liquids and gases; also for sludges, slurries, etc. Separate disc and diaphragm design saves diaphragm wear; permits tight seating even should diaphragm fail. Choose these valves from a wide range of materials, lined or unlined body, for corrosive or ordinary applications. See your Crane Catalog, or your Crane Representative.

THE BETTER QUALITY...BIGGER VALUE LINE...IN BRASS, STEEL, IRON

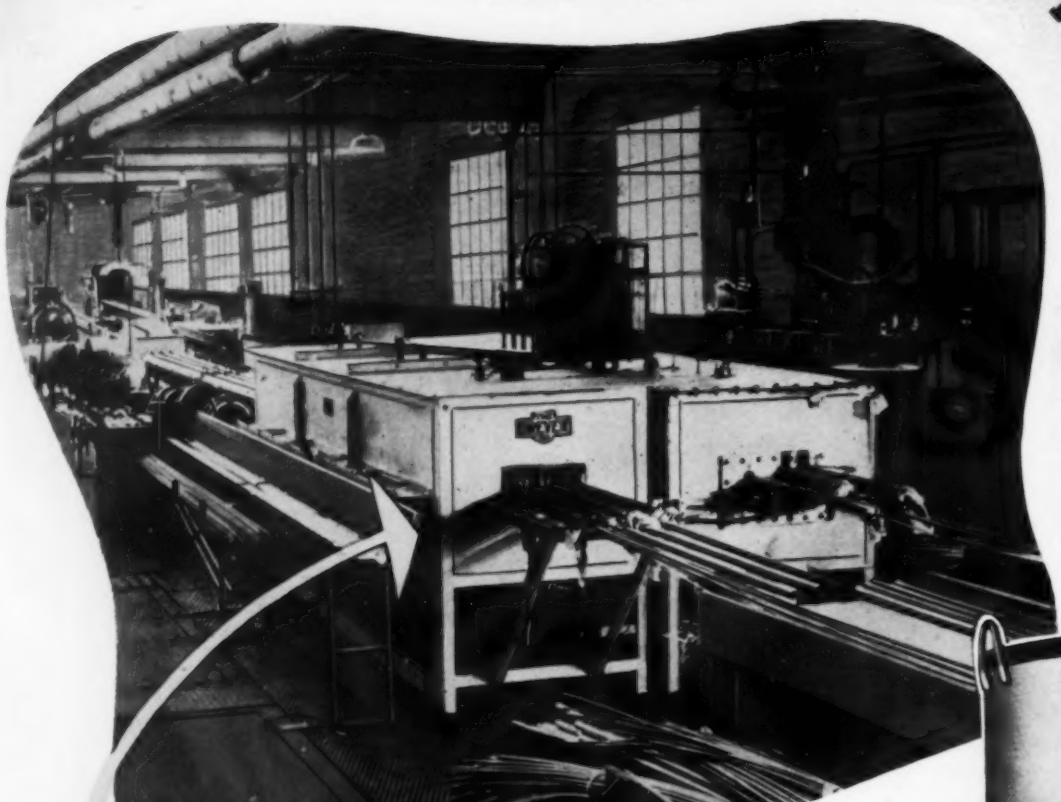
CRANE VALVES

CRANE CO., *General Offices:* 836 S. Michigan Ave., Chicago 5, Illinois
Branches and Wholesalers Serving All Industrial Areas

VALVES • FITTINGS • PIPE • PLUMBING • HEATING

bright annealing

OF STAINLESS STEEL TUBING at 2050°F



THESE ARE THE TWINS

The combination of the Drever TUBE TYPE BRIGHT ANNEALING FURNACE with extended water jacketed cooling chamber, and the Drever AMMONIA DISSOCIATOR provides the right way to BRIGHT ANNEAL STAINLESS STEEL AND INCONEL TUBING.

Let our experience help solve your problems. Write or 'phone

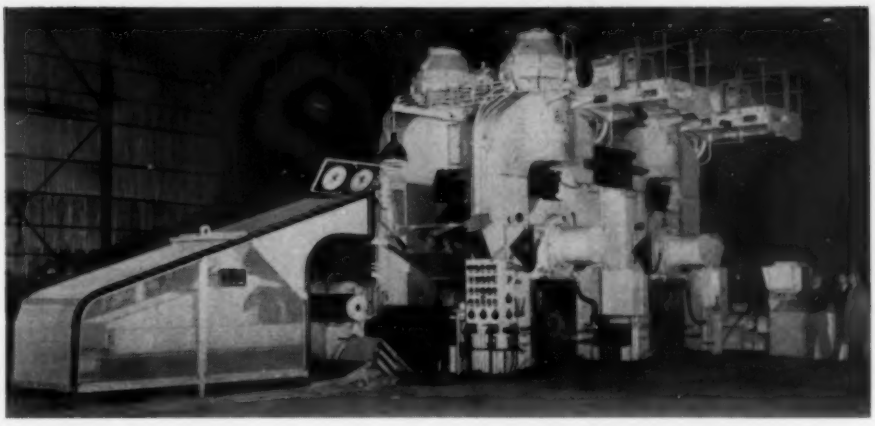
DREVER CO.

730 E. VENANGO STREET • PHILADELPHIA 34, PA.

... here are the facts:

1—Fully Annealed
2—Absolutely Bright
3—No scale, oxides or scratches
4—No Carbide Precipitation
5—No pickling required before drawing
6—No pickling after finish anneal
7—Furnace can be gas or electrically heated
8—Capacities up to 2000 lbs./hour
9—Tubing from capillary size to 2½" O.D.

6



THREE-MAN TEMPER MILL OPERATES AT FAIRLESS

Among important equipment at the United States Steel Corp.'s huge new Fairless works in Morrisville, Pa., is this Bliss two-stand tandem tin temper mill and tension reel, 19 in. and 53 in. x 48 in. The mill is designed to operate at a maximum speed of 3740 fpm. A crew of only three men is required.

The furnace was completely torn down and rebuilt in 39 days as compared to the usual 60 to 80 days required for such a project.

KENNAMETAL ANNOUNCES PRICE REDUCTIONS

▲ Price reductions of from 15 to 20 per cent on many types of metal-cutting tools and tool blanks were announced July 10, by Kennametal Inc., in their Price Discount Sheet No. 52-A.

Single point brazed tools for V-threading and grooving, as well as roller-turners, are now sold at 20 per cent discount from Catalog 52 list prices. All other single point brazed tools are subject to 15 per cent discount from catalog prices.

Kennametal inserts for Kennamatic tools and planer tools; solid boring tool blanks; and blanks for pointed nose tools have also been reduced in price up to 20 per cent.

MOBILE EXHIBIT UNITS SPONSORED BY RELIANCE

▲ Two unusual mobile exhibits of electric motors, motor-drives and associated controls are currently touring through various sections of the country, making numerous stops to visit users of such equipment.

The unique displays, sponsored by Reliance Electric and Engineering Co., Cleveland, Ohio, now enables this pioneer producer of both standard motors and specialized electrical equipment to bring to industry news and views at first-hand of the latest developments and newest improvements in motors, motor-drives and their associated controls manufactured by this 48-year-old firm.

Both of these Reliance touring units have been designed and fitted out to facilitate on-the-spot demonstrations and discussions of production applications involving electric motors, power drives and their related controls with factory and mill management and maintenance men, production managers, plant superintendents, electrical engineers and purchasing agents.

REVEAL LIQUIDATION OF SUBSIDIARY FIRM

▲ Lithium Corp. of America, Inc., has announced that effective July 1, 1953, Lithium is liquidating its wholly owned subsidiary Metalloy Corp. Metalloy previously has operated as the chemical and sales division of the parent company.

This change in no way affects administrative personnel. Hereafter, all business will be conducted under the name of Lithium Corp. of America, Inc.

PICK APPOINTS NEW SALES REPRESENTATIVE

▲ Pick Manufacturing Co. of West Bend, Wisc., announces the appointment of William H. Heagerty, sales engineers, as the representative for Pick instantaneous water heaters in Washington, D. C., Virginia and

MARTINDALE

COMMUTATOR MAINTENANCE EQUIPMENT

COMMSTONES

Manually held Commstones made in a variety of sizes and with various handles. Eight grades available for proper resurfacing of commutators and slip-rings.

TYPE "C" COMMSTONE HOLDER

Holds Commstones rigid and true for concentric resurfacing of commutators and slip-rings while running at normal speeds in their own bearings. Grinds commutators up to 4¾" wide. Used with two Commstones in stone holder or one Commstone in 2" box.

MICA-MILLER UNDERCUTTER

A powerful, light-weight, low cost, easy to use Undercutter, operating from 1/5 h.p. Universal motor. Available with small, medium or heavy-duty head (interchangeable). Also available with air motor or flexible shaft drive.

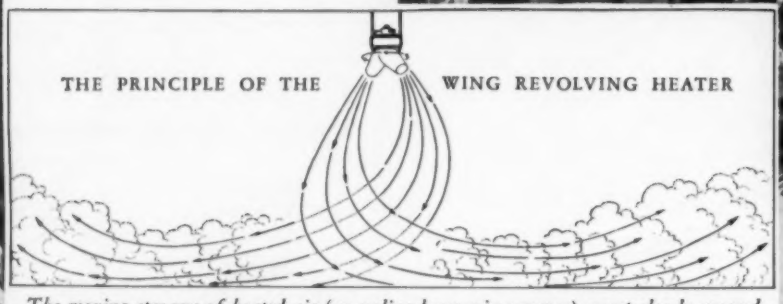
Write for new Catalog No. 29 of Electrical, Industrial and Maintenance Equipment.

MARTINDALE ELECTRIC CO.

1331 Hird Ave. Cleveland 7, Ohio

HEAT THAT MOVES AROUND

THE fact that the discharge outlets of WING Revolving Unit Heaters keep the heated air in constant, gentle motion is one of the reasons why nationally known firms like the Budd Company have installed them in their plants, both at Philadelphia and in the one shown in this photograph, at Gary, Indiana. The big blanking and forming presses in this great plant present a natural barrier to ordinary fixed discharge heating systems, but not to the moving streams of heated air from the WING Revolving Heaters, even suspended, as they must be, far above the floor, to clear the cranes. That is equally true in the summer time when, with steam turned off, the cooling breezes from the revolving discharge outlets keep workers comfortable on the hottest days. Investigate. Write for Bulletin HR-6.



The moving streams of heated air (or cooling breezes in summer) sweep slowly around through 360 degrees, covering successively every direction. The air velocity is sufficient to carry to walls, and remote corners and the constantly changing direction of flow causes the air to find its way around obstructions.

Wing

L. J. Wing Mfg. Co.
142 Vreeland Mills Road
Linden, New Jersey
Factories: Linden, N.J. and Montreal, Can.
In Europe: Etab. WANSON, Brussels, Belgium

Maryland. Offices of the Haegerty organization are located at 1627 K Street, Northwest, Washington, D.C.

TO BUILD WAREHOUSE AT PORTLAND, OREGON

▲ After maintaining their present West Coast offices for more than forty years, Hanchett Manufacturing Co. broke ground on July 10 for a new building which will house the factory, warehouse for replacement parts and the sales and service offices, at Macadam Avenue and Flower Street, Portland, Ore. Increased manufacturing facilities represented by a considerable lot of new machinery, are included in the expansion program. Complete stocks of replacement parts will be carried at the new warehouse so that customer service of the highest and most efficient order will be maintained.

DEDICATE PROCESSING PLANT TO PROFESSOR

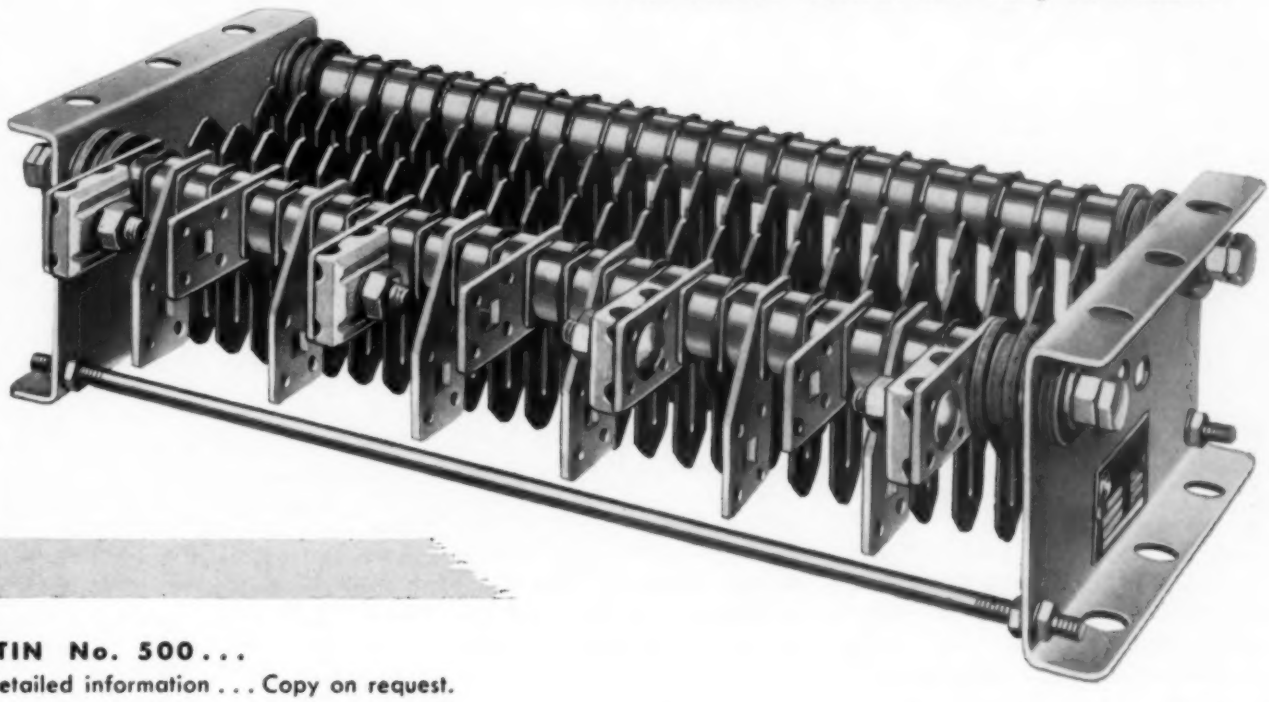
▲ Reserve Mining Co.'s huge taconite processing plant, under construction near Beaver Bay, Minn., has been named the "E. W. Davis Works" in honor of Professor E. W. Davis, long director of the Mines Experiment Station of the University of Minn.

The "E. W. Davis Works," formerly known as Reserve's "Lakeside Project," will have an annual capacity of 3,750,000 tons of iron ore pellets made from taconite in 1957. The company has plans for the possible expansion of this plant to an eventual capacity of 10,000,000 tons of pellets a year.

Taconite mined at Reserve's Babbitt, Minn., pit will be shipped by a 47-mile company-built interplant railroad to the E. W. Davis Works, near Beaver Bay, crushed, ground, magnetically separated, and formed into hard pellets. It will be a continuous year-round operation with pellets being stock-piled during the winter months when the big harbor Reserve is building at the plantsite is closed by freeze-up. Also under construction, near Beaver Bay, is a power plant, sewage and water treatment plants, and a complete new town which is expected to be the largest

P-G *Grids* ASSURE ACCURATE MOTOR CONTROL!

Because the resistance grids used for P-G STEEL GRID RESISTORS are produced in a great number of specific resistance values. Thus the varied current requirements for accurate motor control are easy to obtain.



BULLETIN No. 500...
Gives detailed information . . . Copy on request.

Flexibility in meeting current requirements, enables P-G Steel Grid Resistors to have *both* correct ohmic values as well as required capacities for each application. Naturally, this ability assures accurate *motor control*. Specify P-G for your next application.

P-G

The Nonbreakable Steel Grid Resistor

THE POST-GLOVER ELECTRIC COMPANY

• ESTABLISHED 1892 •

221 WEST THIRD STREET, CINCINNATI 2, OHIO

city on the North Shore, except Duluth, by 1957.

Reserve is operating a taconite processing plant of 300,000 tons per year capacity at Babbitt and is building another town there.

FREYN HEADQUARTERS MOVED TO PITTSBURGH

▲ Headquarters of the Freyn Department, Engineering and Construction division of Koppers Co., Inc., was moved from Chicago, Ill., to Pittsburgh, Pa., effective August 1.

The Freyn executives will have offices on the 10th floor, Koppers Building in Pittsburgh.

Dr. Walter H. Mathesius, a Freyn consultant, will continue to have his offices at 109 N. Wabash Avenue in Chicago, as will several members of the Freyn sales force and the entire engineering department.

Koppers purchased Freyn Engineering Co. in 1949 and it now operates as a department of Koppers Engineering and Construction Division. Freyn designs and constructs blast furnaces, open hearth furnaces, sintering plants, continuous casting machines and much other equipment for the steel and allied industries.

GIANT PRESS COLUMN SHIPPED BY UNITED

▲ A 200 ton steel column was recently shipped from the New Castle, Pa., plant of the United Engineering and Foundry Co. This is one of four such columns that will be needed for an 8,000 ton forging press that United is building for the United States Air Force. The column measures 52 ft long, 7 ft wide and 9 ft high and is one of the largest castings ever produced by United.

Leaving the Lee Wilson Engineering Co., Inc., Cleveland, for an inspection trip to their assembly plant in Elyria are: (front row) R. L. Corbett, C. F. Olmstead, president, Lee Wilson, chairman of the board, J. L. Whitten, vice president, W. A. Marquardt, E. A. Corns, export manager; (back row) C. C. Blackman, W. E. Spaninger, E. F. Dreher, V. L. Miller, J. H. Werner, John Arnold, chief engineer, and J. L. Kozma.

This is the first of 25 large castings which are being cast by United for the U. S. Air Force heavy press program. In addition to the 8,000 ton forging press, United is also building a 35,000 ton forging press and a 12,000 ton extrusion press.

TOUR ASSEMBLY PLANT ON 20TH ANNIVERSARY

▲ Born in the depression, a Cleveland, Ohio, industrial furnace firm has grown in 20 years to world-wide prominence in its field. This is the Lee Wilson Engineering Co., Inc., whose founder and board chairman, Lee Wilson, invented the radiant tube annealing system now used in every leading steel making center of the world.

Latest addition to this steadily expanding company is an assembly plant in Elyria, Ohio, which turns out the furnaces completely assembled for shipment to all parts of the United States and abroad. This is a great advance over the old method of sending the many items needed in furnace construction to the installation site and erecting on the job.

In conjunction with the company's 20th anniversary, district sales managers recently met at the home office to learn the latest developments in their product and to see the equipment in various phases of construction and finished form at the assembly plant.

CONSTRUCT ANNEALING FURNACE IN ALABAMA

▲ Rust Furnace Co. is constructing a new continuous pipe annealing furnace for the McWane Cast Iron Pipe Co. of Birmingham, Ala.

Designed to anneal centrifugally cast iron pipe, the new furnace will handle two and three-inch diameter pipe in lengths up to 20 ft. It has a capacity of about 15 tons per hour, can be fired with either gas or oil, and is equipped with three zones of temperature control.

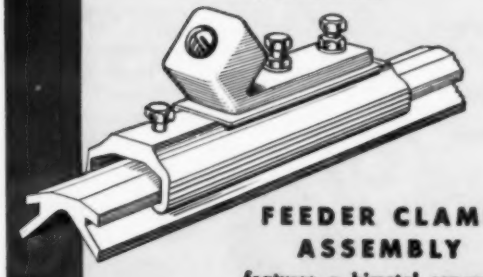
AWARD EXTRUSION PRESS CONTRACT TO HYDROPRESS

▲ Hydropress, Inc., New York, has been awarded a contract for a 2,400-ton capacity hydraulic extrusion press and accumulator station by the government owned brass plant in Ankara, Turkey.

The Keystone INTEGRATED ALUMINUM* Conductor System

HANGER SECTION
Conductor free to slide within support, allowing for expansion and contraction.

JOINT PLATE AND BOND ASSEMBLY
Non-loosening spring-type splice plate provides excellent electrical and mechanical joint characteristics between conductor sections.



FEEDER CLAMP ASSEMBLY
features a bimetal separator that eliminates galvanic corrosion between copper terminal and aluminum surface, providing foolproof, long-lasting connection.

LOWER COST
LIGHTER WEIGHT, HIGHER EFFICIENCY
SAFER ENCLOSURES

An integrated power supply system designed to complement the best materials handling equipment—1000 amperes capacity for heavy duty systems . . . economical for use on control circuits.

The Keystone Aluminum Conductor System is now being employed in outstanding installations, after having been developed through years of research in the laboratory and industry. It has been carefully designed to solve the troublesome problems formerly encountered.

The light weight of this conductor system reduces costs of installation, insulators and supporting structures. Its non-corrosive qualities permit use on sensitive control circuits. Longer contact life. Compact design saves space, permits better protection. All components are pre-fabricated. Available complete with brackets and enclosures. No copper boosters nor priorities needed. Easily engineered, installed and maintained.

*Domestic and Foreign Patents Pending

Write today for new, illustrated 4-page folder on Keystone Integrated Aluminum Conductor System.

ELECTRIC SERVICE MANUFACTURING CO.

PHILADELPHIA 32, PENNA

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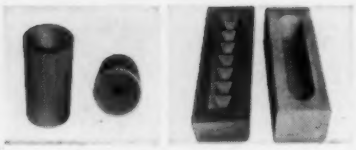
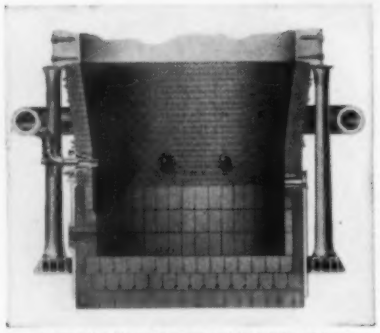


GRAPHITE MOLDS

GRAPHITE SINTERING BOATS & TRAYS



CARBON BLAST FURNACE LININGS

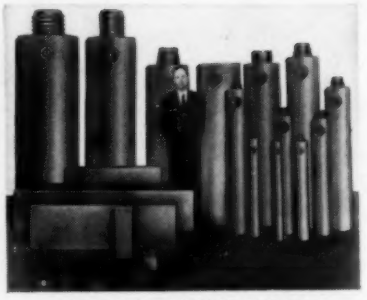
GET MORE TONNAGE FOR LESS

WITH THESE

NATIONAL

TRADE-MARK

Carbon and Graphite Products

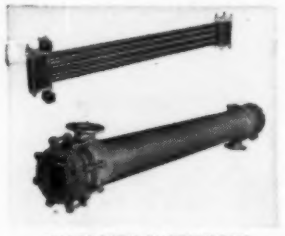


CARBON & GRAPHITE ELECTRIC FURNACE ELECTRODES

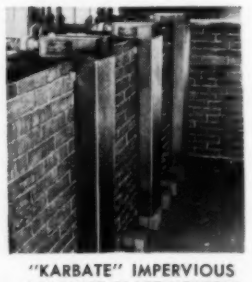
GRAPHITE FLUXING TUBES

CARBON LININGS FOR RUN-OUT TROUGHS

CARBON CINDER NOTCH LINERS



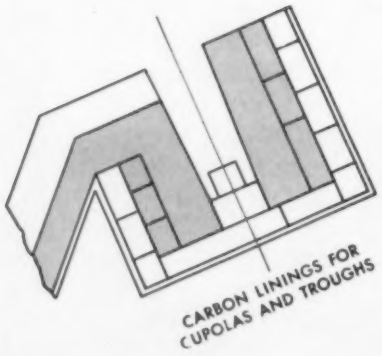
"KARBATE" IMPERVIOUS GRAPHITE HEAT EXCHANGERS



"KARBATE" IMPERVIOUS GRAPHITE PLATE HEATERS AND CARBON TANK LININGS

NO OTHER MATERIAL PROVIDES THIS COMBINATION OF PROPERTIES!

- **Chemically inert**
- **Does not melt**
- **Low coefficient of thermal expansion**
- **Good thermal conductivity**
- **Excellent electrical conductivity**
- **Non-contaminating**
- **Resists wetting by molten metal and dross**



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Personnel News...

T. H. Hagan was named superintendent of steel works for the Southern district of Republic Steel Corp., Gadsden, Ala. **J. J. Lloyd** was appointed superintendent of the sheet mill and **J. L. Hamilton** was made assistant superintendent of the sheet mill. Mr. Hagan worked with American Rolling Mills Co. in open hearth operations for three years at Middletown, Ohio, and then transferred to the company's Ashland, Ky., plant as an open hearth fuel man for three years. He went to work in Republic's Gadsden plant in 1930 as combustion engineer at the sheet and plate mills. He was made general foreman of the sheet mill in 1940 and became chief engineer of power in 1942. He returned to the sheet mill as superintendent of the department in 1944. Mr. Lloyd began working for Newton Steel Co. in Newton Falls, Ohio, in 1929. He transferred to Monroe, Mich., with the same company in 1930 and worked there until he accepted a job as sheet finisher in Republic's Gadsden plant in 1933. He was promoted to turn foreman in the sheet mill in 1937 and to assistant superintendent of the sheet mill in 1946. Mr. Hamilton began working in the Gadsden steel mill in 1928 as a reelman in the field fence department of the wire mill. He transferred to the sheet mill in 1930 and worked on various jobs until he was made general foreman of the shearing and opening department in 1934.

James J. Dalton was named division superintendent in the cold roll division at American Steel & Wire's Cuyahoga Works, Cleveland, Ohio. Mr. Dalton's appointment fills the vacancy created by the death last February of **Carl L. Radway.** Mr. Dalton has been serving as assistant division superintendent.

Lawton Howell was named to the position of works controller at the Sanderson-Halcomb Works of Crucible Steel Co. of America in Syracuse, N. Y. Mr. Howell started at the company's Midland, Pa., works in 1945. He advanced to the position of general accountant in 1947, and since 1951 has supervised all cost accounting at the Midland operations site. **F. W. Bloom** will succeed Mr. Howell as cost accountant at Midland. Mr. Bloom started at Crucible's Midland works in 1942 and was promoted to supervisor of cost and production accounting in 1950.

Charles E. Reiter has been appointed manager of the general order department of Republic Steel Corp. to succeed **R. J. Morgan** who will retire after a 54-year career in the steel industry. Prior to Mr. Morgan's retirement, Mr. Reiter was assistant manager of the department. He has been associated with Republic or predecessor companies for 33 years. Mr. Morgan began his career in 1899 as an invoice writer with Carnegie Steel Co. in Pittsburgh, Pa. In 1913, Mr. Morgan went to Cambria Steel Co., Johnstown, Pa., as manager of accounts receivable. Subsequently, he was employed by American Steel Export Co., New York, N. Y., Donner Steel Co. of Buffalo, N. Y., and Pittsburgh Crucible Steel Co. He came to Republic as manager of orders in May, 1930, just one month after Republic was formed.

M. Milo Millette has been appointed works manager at the American Car and Foundry Co.'s Buffalo, N. Y., plant. Mr. Millette, who has been acting head of this plant since February, will be in charge of all engineering and production which ACF is performing for the Department of Defense and other U. S. Government agencies at that point, in addition to regular industrial work.

Harold B. Ressler, chairman of the executive committee of Joseph T. Ryerson & Son, Inc., retired from active service June 30. Mr. Ressler remains a director. Mr. Ressler was second oldest in point of service of the more than 4,000 Ryerson employees. He took his first, and only job, with Ryerson in 1905.

I. Melville Stein was elected president of Leeds & Northrup Co. Mr. Stein, formerly executive vice president, succeeds **Charles S. Redding** who, after 14 years as Leeds & Northrup president, becomes chairman of the board, a post which has been vacant since the death of Morris E. Leeds in 1952. Other changes in management responsibilities also were announced. D. H.

T. H. HAGAN

J. J. LLOYD

J. L. HAMILTON

JAMES J. DALTON

Schultz, who has been secretary and treasurer since 1940, succeeds Mr. Stein as executive vice president while retaining the duties of treasurer. **George W. Tall, Jr.,** vice president, assumes the additional post of secretary.

William A. Haven a vice president of Arthur G. McKee Co., Cleveland, Ohio, has retired. Mr. Haven, who has been in charge of the company's metals division, will continue as a director of the company and as a consultant. Mr. Haven has been a vice president of the company for the past 25 years. As the result of Mr. Haven's retiring as an officer, the board of directors elected **Merrill Cox,** vice president, metals division, administration and sales; and **A. L. Foell,** vice president, metals division, in charge of engineering. Both Mr. Cox and Mr. Foell have been with the company for 24 years. Mr. Cox, presently general sales manager of the metals division, has also held the positions of service engineer, assistant chief engineer, and sales manager of the metals division. Mr. Foell, until he became technical director of the metals division a year ago, had been chief engineer of that division since he became associated with the company in 1930.

F. Richard Meyer III was named assistant to the president of Acme Steel Co., Chicago, Ill. Mr. Meyer replaces **Christopher D. Norton** who was elected vice president of Acme Steel International Co. and Acme

F. RICHARD MEYER III

Steel Overseas Co., both subsidiaries of Acme Steel Co. Mr. Meyer joined Acme Steel in August, 1949, and was named manager of commercial research in April, 1950. Prior to joining Acme Steel, he was with Stewart Warner Corp., Chicago, Ill.

George A. Fort and **Eugene C. Kennedy** were named division superintendent and assistant division superintendent, respectively, at the Gary, Ind., works coke plant of United States Steel Corp.

Mr. Fort succeeds **James McIntosh** who retires on July 31 after 48 years of service with the corporation.

Mr. Fort has been serving since December, 1946, as assistant division superintendent of the coke plant. Mr. Kennedy, who succeeds Mr. Fort as assistant division superintendent, has been employed at the Gary coke plant since 1936.

Jack W. Walling has been appointed manager of industrial relations for Kaiser Engineers Division of Henry J. Kaiser Co., Oakland, Calif. Mr. Walling formerly was assistant to vice president of operations at the

JACK W. WALLING

Fontana works of the Kaiser Steel Corp. and was responsible for the Fontana steel plant's legal, industrial and public relations departments.

C. E. Magoon has been appointed treasurer, National Tube division of United States Steel Corp. Mr. Magoon succeeds **H. J. Hirshman** who is retiring after 49 years service with National Tube, 30 years of which he has been treasurer. Mr. Hirshman will remain active in the United States Steel division in a consulting capacity.

Mr. Magoon was named assistant treasurer in 1944, a position he held at the time of his new appointment.

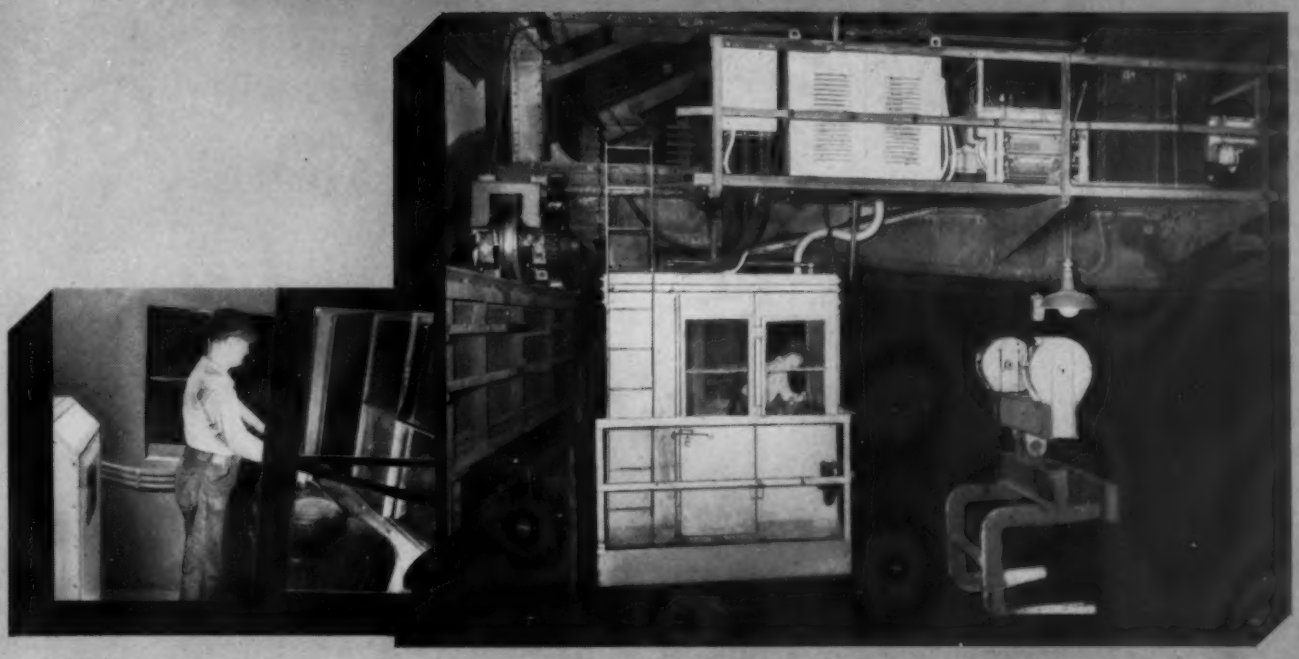
Robert S. Sagers has been appointed manager of the New England district of Kennametal Inc., Latrobe, Pa. Mr. Sager has been service and sales representative in Kennametal Middle Atlantic district since 1946.

Arthur V. Peterson, formerly with the Atomic Energy Commission, has joined the staff of the vice president in charge of engineering of American Machine & Foundry Co., New York, N. Y.

Donald I. Bohn, chief electrical engineer for Aluminum Co. of America since 1945 and **Louis N. Grier,** assistant chief electrical engineer, have been named to new posts with Alcoa. Mr. Bohn, whose career with Alcoa extends over a period of more than 30 years, will head up special electrical development engineering work. Mr. Grier, who also has more than 30 years service with Alcoa, will assume the post of chief electrical engineer.

Frank H. Cassell was appointed manager of industrial relations and **Dr. E. H. Carleton** as general medical director for Inland Steel Co., Chicago, Ill. Mr. Cassell,

CRANE CAB operating temperatures lowered 65° to 70° F. at Hot Slab Mill



DRAVO SPLIT-TYPE CRANE CAB COOLER INSTALLED AT PITTSBURGH STEEL CO.

Hot slab mill operations produce ambient temperatures in summer of 150° F., creating a major working hazard for crane operators working over these "hot spots."

Pittsburgh Steel Company at Monessen, Pa., eliminated this hazard with a Dravo split-type Crane Cab Cooler. With the condenser section mounted on the crane and the conditioning section in the cab, crane cab temperatures are kept at 80° to 85° F. regardless of sudden temperature changes outside. Crane operators are healthier, more alert and more efficient.

CRANE CAB COOLERS PROVIDE YEAR-'ROUND AIR CONDITIONING

Dravo Crane Cab Coolers are ruggedly constructed, factory assembled and pre-tested to provide years of more-than-satisfactory service. All equipment in the unit is readily accessible with ample space for quick and efficient maintenance.

In the various air conditioning functions the crane cab cooler not only filters the air, removes dust, dirt and fumes, but heats the cab in winter, cools it in summer and provides constant ventilation the year around.

AVAILABLE IN SINGLE OR SPLIT-TYPE UNIT: IMMEDIATE DELIVERY

Dravo Crane Cab Coolers are built in two models—the self-contained unit, mounted on any available space on the crane and the new split-type unit where the condenser section is mounted on the crane, with the conditioning section in cab.

The Dravo Crane Cab Cooler can be easily and quickly installed on any type of crane with a minimum of down-time required. Units are available now! Write for more information —or phone the nearest Dravo Office and have our representative call on you. Ask for Bulletin QC 13

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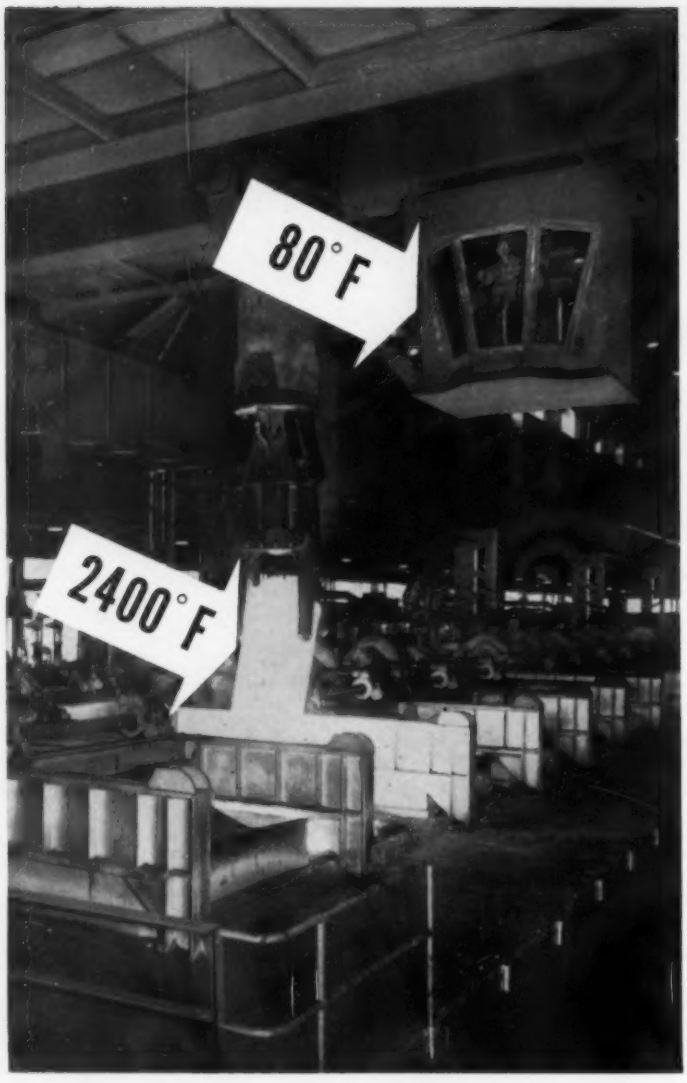

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Here is a hot job in a large steel mill. Every time the crane taps a pit, it picks up a mass of molten metal at 2400 F. for delivery to the receiving table. Blasts of hot air soar upward.

Yet — the crane operator works efficiently in a comfortable temperature due to a Lintern Aire-Rectifier. The cab unit is located conveniently in the cab and the condenser unit on the footwalk.

Five cranes and two pulpits are air conditioned in this plant — and more are planned. These Aire-Rectifiers mean greater production, improved employee relations and less turnover of skilled labor.

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THE LINTERN CORPORATION

Route 20, East Painesville, Ohio

formerly assistant to the manager of industrial relations, joined Inland in 1947 and headed the industrial relations research department and wage and salary administration section at the company's Indiana Harbor, Ind., works. Dr. Carleton, who has been director of the medical department at Indiana Harbor, will now supervise a general medical program covering Inland and its subsidiary firms.

Stephen Rasul was named manager of design and production engineering for Acme Steel Co.'s Riverdale,

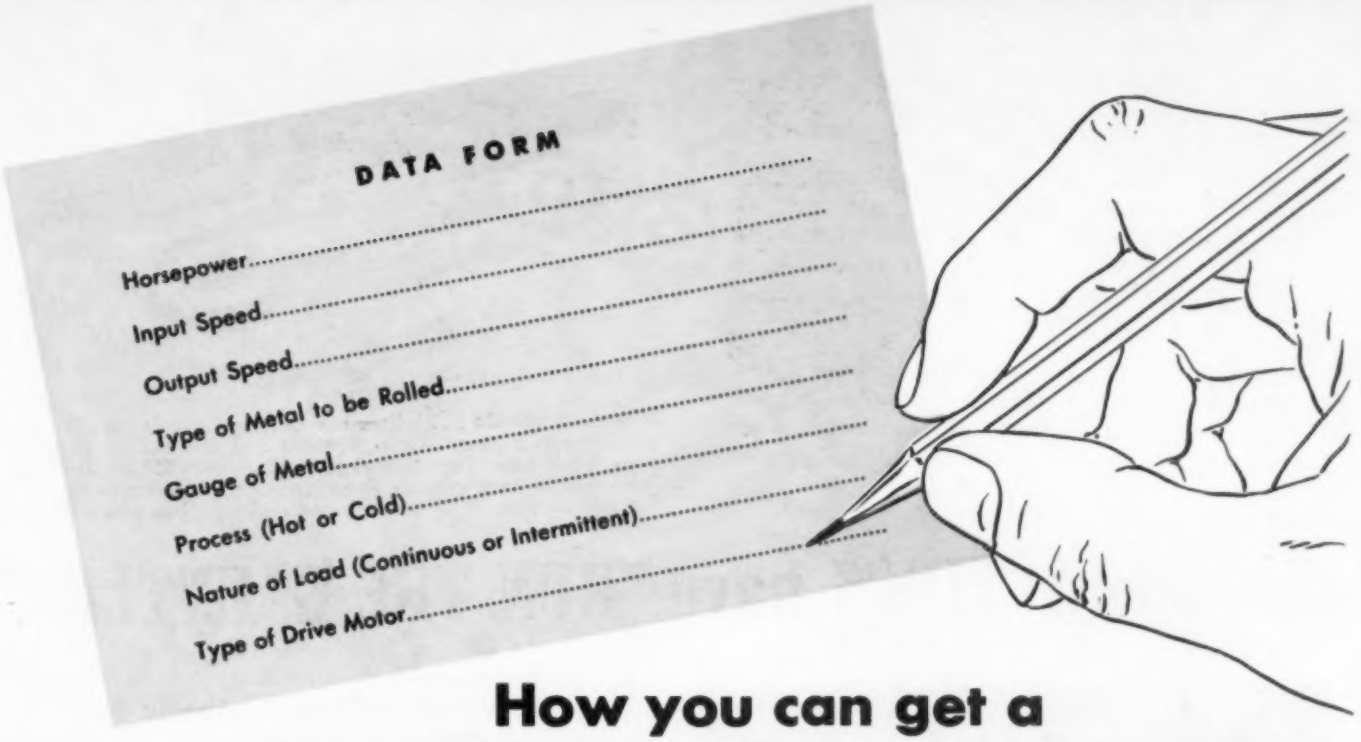
STEPHEN RASUL

Ill., plant. **Thomas Fullerton** has been named chief engineer in charge of all machine design and production engineering activities. Mr. Rasul joined Acme 35 years ago and has served in various engineering capacities with the company during that time. Mr. Fullerton

THOMAS FULLERTON

joined Acme Steel in 1946 after serving in various engineering capacities with Warner and Swasey, Cleveland; Mechanical Handling Systems, Detroit; and with the Ordnance Division of the U. S. Army.

George M. Thursby was named vice president—industrial relations administration, United States Steel Corp., Pittsburgh, Pa. Mr. Thursby has been vice president—industrial relations administration—coal, since 1951. His new position consolidates the responsibilities



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Farrel gear drives, pinion stands and combination units are designed and built to suit your needs exactly.

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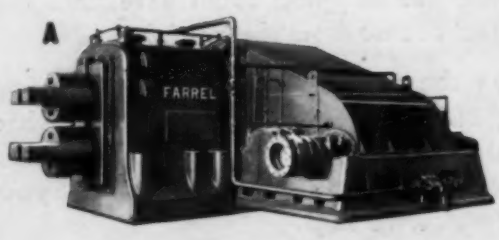
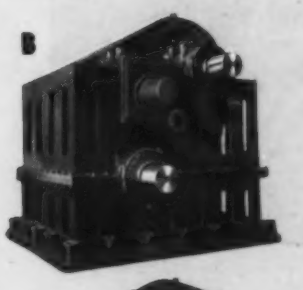
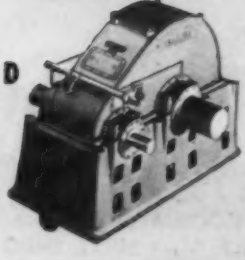
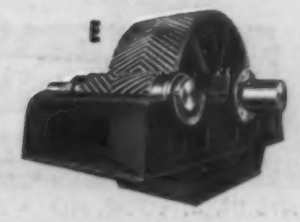








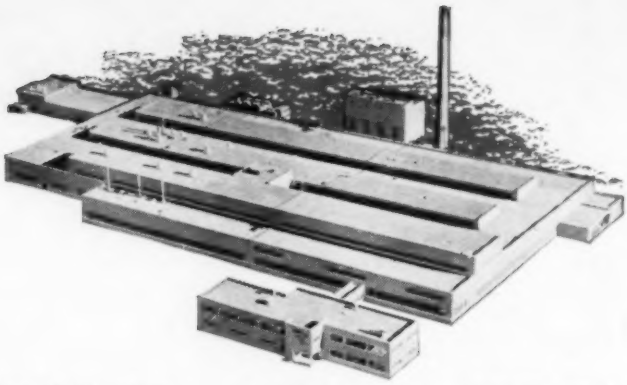
A—1250 HP, 600 RPM double reduction unit combined with 26" two-high pinion stand

B—10,000 HP piercing and expanding mill drive

C—150 HP tube mill drive, triple reduction, 113:1 ratio

D—800 HP cold strip mill drive

E—1500 HP reversing reel drive (with cover removed)



N-B-M Meadville . . . where the welcome mat is out. We're proud of this plant—its equipment and the skilled people who work in it. Proud enough, in fact, to offer a standing invitation to Blast Furnace Superintendents or other steel mill officials to visit us. When can *you* make an inspection trip?

These CASTINGS have "RUN THE GAUNTLET"

Here's where you'll find copper castings that have been subjected to rigid tests for soundness and quality.

Another Reason why N-B-M Meadville is a name to remember when you specify copper castings. What does your eye tell you when you see this picture? Chances are, "a big selection of copper castings". And, it's true that this big selection is typical of the wide range of copper castings that N-B-M Meadville is equipped to produce.

But, there's something more important that no ordinary photograph can show . . . because each of these castings has its own "success story". Each has been subjected to the most painstaking system of production and quality control that you'll find in any foundry . . . anywhere. That's why we say that castings reaching our shipping room have "run the gauntlet" . . . *we know they're right.*

From the molding floor to the shipping room, N-B-M Meadville accomplishes what should be, and is, the main objective of this modern, well-manned plant . . . ***what you specify . . . we ship.***

AMERICAN **Brake Shoe** COMPANY

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of vice president—industrial relations administration—coal, and vice president—industrial relations administration—steel.

Leo Teplow was appointed industrial relations consultant of America Iron and Steel Institute, New York, N. Y. In the newly created position, Mr. Teplow will also serve as secretary of the Institute's Committee on industrial relations and of two related committees, industrial health and safety. In his new work, Mr. Teplow will take over the duties heretofore performed by **Grover C. Brown,** who on September 30 will retire after 36 years in the iron and steel industry of the United States, including 20 years as secretary of the Institute's Committee on Industrial Relations.

Dr. Robert F. Mehl, head of the metallurgical engineering department and director of the metals research laboratory at Carnegie Institute of Technology, Pittsburgh, Pa., will immediately assume his new appointment as dean of graduate studies in addition to his present positions. He will be assisted by **Admiral Joseph Ludewig,** associate professor of metallurgical engineering in administering his duties in the metals research laboratory and the metallurgical engineering department.

Edward E. Hill has been named assistant chief inspector for the Worcester Pressed Steel Co., Worcester, Mass. Mr. Hill, who has been associated with Worcester Pressed Steel Co. for the past ten years, will assume his new duties immediately.

E. H. Schoonmaker has been appointed district manager of the St. Louis, Mo., district sales office for the Eddystone Division of Baldwin-Lima-Hamilton Corp.

William G. Gerstacker was named chief engineer of Heil Process Equipment Corp., Cleveland, Ohio. Mr. Gerstacker has had 18 years experience as estimator, product manager and chief engineer with other process equipment manufacturers principally in the chemical plant equipment field. Other recent additions to the Heil staff include the appointment of **John M. Carpenter** as estimator in the lining and coating department and **Frank Babik** as estimator in the fabrication department.

J. W. Campbell has been named assistant works manager of Colorado Fuel and Iron Corp.'s Wickwire-Spencer plant in Buffalo, N. Y. Mr. Campbell assumes his duties as second in command of CF&I's second largest plant after 27 years of service with the corporation. Since 1950, he has been wire mill superintendent of the Buffalo plant.

Gerald F. Propst was appointed assistant superintendent of industrial relations at Republic Steel Corp.'s Cleveland, Ohio, steel plant. This creates a second assistant superintendency in the department, headed by **Edward Mandry. C. F. Sells** will continue to serve as assistant superintendent, a post he assumed in 1943. Mr. Propst, had been serving as supervisor of training since August, 1950.

L. H. Oppenheim, has been named a vice president of the Henry J. Kaiser Co., Oakland, Calif., parent company of the Kaiser group of industries. He will continue to serve as assistant general manager of Kaiser Engineers, a division of the parent firm.

C. I. Bradford has been appointed vice president and director of operations, and **W. E. Gregg** has been appointed assistant director of operations of Rem-Cru Titanium, Inc., jointly owned by Remington Arms Co., Inc., and Crucible Steel Co. of America. Mr. Bradford was formerly director of operations, and Mr. Gregg was assistant treasurer of Rem-Cru.

C. I. BRADFORD

Carl Persson was made assistant chief engineer, machine design engineering department for Acme Steel Co., and **Hugo H. Gustafson** as assistant chief engineer, production engineering department, at the company's Riverdale plant, Riverdale, Ill.

G. Lynn Coane has been appointed sales engineer in the commercial weldment department of Baldwin-Lima-Hamilton Corp. Before joining Baldwin, Mr. Coane was employed by the U. S. Army Ordnance Department as inspector of heavy forgings, weldments and castings.

C. E. Ford was made manager, chemical carbon sales department, of National Carbon Co., a division of Union Carbide and Carbon Corp. Mr. Ford has had various administrative assignments in the industrial sales department, leading to his present appointment.

E. A. Hakanson was named manager of the Chicago, Ill., district, which includes northen Illinois and Wisconsin, for Appleton Electric Co. Associated with Appleton for thirty-two years, Mr. Hakanson has served the entire period with the sales department of the Chicago manufacturer. Prior to his appointment as dis-

trict manager, he was a field engineer in the Chicago district.

Gerald R. Gonyer has been appointed manager of the Chicago, Ill., office, of Farrel-Birmingham Co., located at 120 So. LaSalle Street. Mr. Gonyer succeeds **Harry Temporal** whose retirement is effective Septem-

GERALD R. GONYER

ber 1st. Mr. Temporal is terminating 43 years service with the company. Mr. Gonyer's entire business career has been with Farrel-Birmingham since he joined the company in Ansonia in 1937.

Nils H. Lagerstrom was appointed vice president of Damascus Tube Co., Greenville, Pa. Mr. Lagerstrom was formerly general manager of the company. He will begin his new duties immediately. Mr. Lagerstrom was operating superintendent and construction engineer for the National Tube Co. division of U. S. Steel Corp. prior to joining Damascus Tube.

Dr. Otto J. Stern was named head of the research and development department of Air Products, Inc., Allentown, Pa. Dr. Stern came to Air Products from the Massachusetts Institute of Technology where he was technical and executive associate to Professor S. C. Collins.

H. L. Ingram, Jr., Airco's special representative, Washington, D. C., has been appointed manager of the technical development department of Air Reduction Sales Co., New York, N. Y. Mr. Ingram has been with Air Reduction for 18 years. For five years he was with the applied engineering department, another five with the gas sales department and eight years as special representative with offices in Washington, D. C., a post he held until this appointment.

W. W. Kerlin has been appointed manager of service engineers for the Meehanite Metal Corp., New Rochelle, N. Y. Mr. Kerlin, who joined the Meehanite organization over 20 years ago, has been a member of the service staff operating from their Cleveland, Ohio office. Mr. Kerlin will now make his headquarters at the New Rochelle offices of Meehanite Metal.

Robert Barefoot was appointed to the Cleveland offices of Dravo Corp., machinery division, located at 4207 Chester Avenue, Cleveland, Ohio. In his new position, Mr. Barefoot will handle the sale of the products of Walker Process Equipment, Inc. Mr. Barefoot was formerly connected with Walker Process as a field engineer. **D. H. Felix** was named to the staff of the Chicago office, as sales engineer. The offices are located at 208 South LaSalle Street, Chicago, Ill. Mr. Felix will handle the sale of Dravo warm-air space heaters, crane cab coolers, Trion electronic filters, fly ash arrestors and "Oxy-Cat" units. Mr. Felix in his three years of employment with Dravo has served in various capacities. **E. G. Counselman** was made sales engineer for the machinery division in the metropolitan New York territory. Dravo Corp. office is located at 30 Church Street, New York, N. Y. Mr. Counselman will handle the sale of Dravo "Counterflo" heaters. **John Schuster** was moved to the Detroit, Mich., offices, located in the Boulevard Building. Mr. Schuster will handle the sale of the Dravo "Counterflo" heater in the Michigan territory. Mr. Schuster was formerly connected with the heating department of the Pittsburgh office of Dravo as a mechanical engineer.

B. Otto Wheeley was appointed southern district sales manager for the Tar Products Division of Koppers Co., Inc. Mr. Wheeley, who has been assistant district manager, with headquarters in Birmingham, Ala., succeeds **F. G. Owen,** who died June 21.

Donald S. Myers was appointed industrial sales engineer in the Pittsburgh, Pa., district of Surface Combustion Corp. Mr. Myers will work with **Donald K. Martin,**

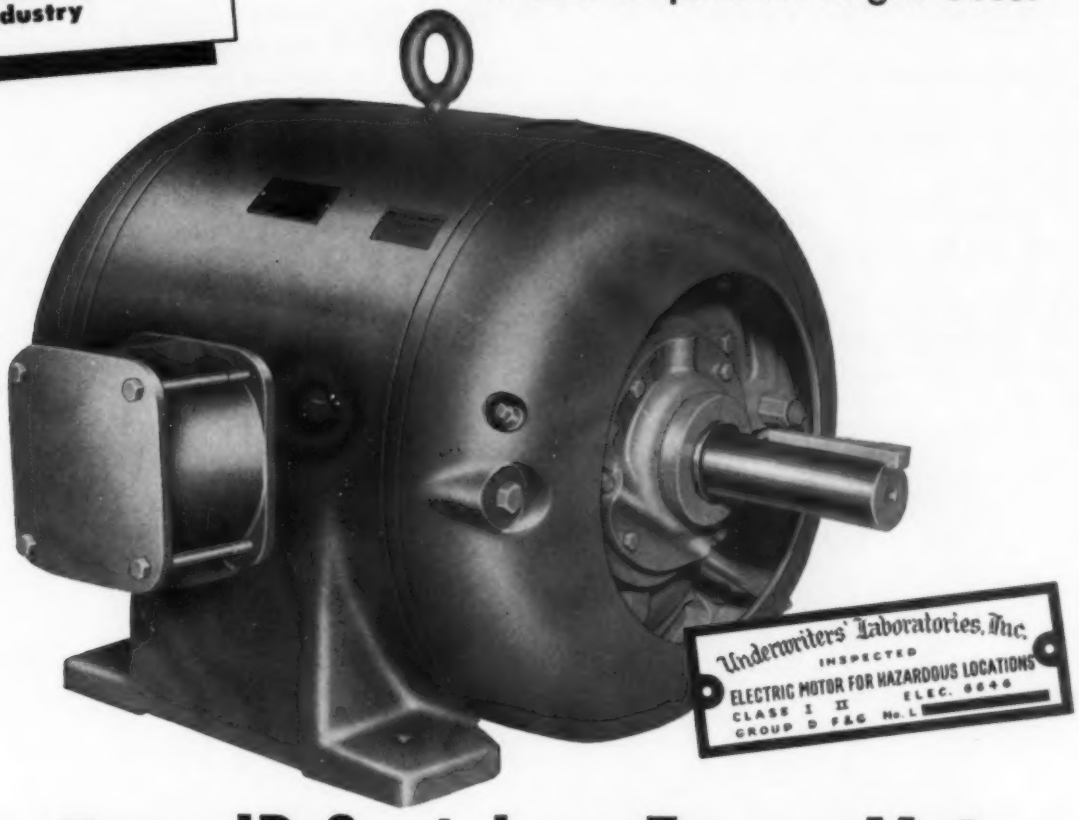
DONALD S. MYERS

district manager of Surface Combustion's Pittsburgh office. Since joining Surface in 1934, Mr. Myers has devoted his entre time to the field erection of furnaces for the steel mill, heat treat and glass divisions of the company.

George R. Lundberg, formerly of the brush division of Osborn Manufacturing Co., Cleveland, Ohio has been promoted to sales manager. **Frederic T. Turner,** formerly assistant sales manager, has been named manager, market research. **Everett A. Sisson,** formerly sales

Wagner
ELECTRIC MOTORS
...the choice of leaders in industry

...where corrosion is a problem
...where explosion might occur



Wagner Type JP Cast Iron Frame Motors

Wagner type JP cast iron frame motors are built for use in chemical plants, oil fields, refineries, steel mills—for any application where corrosive and explosive conditions might prevail.

These rugged motors are totally-enclosed in rust- and corrosion-resistant cast iron. They are fan-cooled by an externally mounted blower, made of non-sparking bronze, that forces air through ventilating passages in the frame. They feature completely protected laminations . . . special varnish treated windings . . . a running shaft seal . . . and an explosion-proof conduit box with machined fits.

A standard type cast iron frame motor (for applications where protection against explosion is not required is also available. Both types are built in ratings from 2 to 250 hp, with either normal or high torque characteristics.

Wagner Bulletin MU-132 gives complete information on these protected motors. A nearby Wagner engineer can help you select a Wagner Motor to meet your most exacting specifications. Consult the nearest of our 32 branch offices, or write us.

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AUTOMOTIVE BRAKE SYSTEMS — AIR AND HYDRAULIC

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M53-9

project supervisor, has been elevated to assistant sales manager. **Alfred J. Chandler,** formerly assistant manager, industrial sales, has been named manager, industrial sales. **C. A. Dolby,** formerly advertising and sales promotion manager has been promoted to manager, distributor sales. **Richard M. West,** formerly assistant advertising and sales promotion manager has been promoted to advertising manager.

Roy E. Hum, for nearly 13 years general foreman of the shops department at Brier Hill works, Youngstown Sheet and Tube Co., Youngstown, Ohio, has been appointed superintendent of maintenance (electrical) at Brier Hill. He succeeds **Norman P. Hitchcock** who has advanced to assistant superintendent of maintenance, succeeding **M. A. Manley,** retired.

J. R. Johnstone was named manager, carbon products sales department, of National Carbon Co., a division of Union Carbide and Carbon Corp. Mr. Johnstone has

J. R. JOHNSTONE

been with National Carbon Co. since 1937. He was engaged in various sales and administrative functions before being given his present assignment.

Alan E. Bodycombe of Alan E. Bodycombe and Associates, 18401 E. Warren Avenue, Detroit, Mich., has been selected by Protective Coatings, Inc., Cleveland, Ohio, to represent them in Michigan. **J. Whitney Cooper** of 56 Dartmouth Avenue, Rochester, N. Y., was named to represent them in the upper New York state. **Harry L. Showalter, Jr.,** industrial consultant and president of Girard Associates, Chambersburg, Pa., was named as representative in the Middle Atlantic States and in certain contiguous areas including the District of Columbia.

Thomas E. Lloyd has been named director of sales of Salem-Brosius, Inc. Mr. Lloyd, sales manager since February, 1952, will be in charge of all sales activities, including the coordination of industrial and commercial sales. **John W. Holzwarth** has been appointed sales manager, industrial products. Mr. Holzwarth served as sales engineer for Salem-Brosius, Inc. since he joined the organization in 1951. He was formerly associated with the Electric Furnace Co., Salem, Ohio. **H. L. Lloyd** has been appointed chief engineer. Prior to joining Salem-Brosius, Inc. in 1941, Mr. Lloyd was with Volcanic Specialty Co., Alliance, Ohio. He is succeeded as combustion engineer by **C. L. Kerr,** formerly assistant combustion engineer. Mr. Kerr served with Wheeling Steel Corp., Steubenville, Ohio, before joining Salem-Brosius, Inc. in 1947. **E. T. Trebilcock** and **R. B. Powers** have been named sales engineers of steel mill heating furnaces and heat treating equipment.

H. H. Zollar has been made general manager of Shenango-Penn Mold Co.'s centrifugal castings division, Dover, Ohio. As the Dover division's new general manager, Mr. Zollar, formerly manager of sales, is now responsible for all sales, plant operations, office management and other company activities on a local level.

Abner H. Bagenstose has been made eastern regional manager, for Insul-Mastic Corp. of America and **John J. Miller** has been placed in charge of the midwestern territory. The two men will work from the home office of the Insul-Mastic Corp. in Pittsburgh, Pa. As company representatives, they will give technical and sales assistance to the contracting firms in principal cities who are licensed to sell and apply Insul-Mastic's line of protective coatings.

Robert L. Clark has been appointed director of purchases at Kropp Forge Ordnance Co., Melvindale, Mich., a subsidiary of Kropp Forge Co. Mr. Clark, who was formerly assistant purchasing agent at Kropp Forge Co., Chicago, Ill., has been with the firm for the past three years. Prior to that, he served seven years as buyer for Santay Corp. of Chicago.

William G. Hill has been named a sales engineer for General Dynamics Corp.'s Electro Dynamic Motor and Generator Division. Mr. Hill will serve in New England. Prior to representing Electro Dynamic, Mr. Hill worked for George H. Dean, Inc., and the Universal Winding Corp.

John A. Marsh, assistant vice president and manager of operating department of International Nickel Co., Inc., has been elected vice president of the company. Mr. Marsh is in general charge of all plant operations in the United States.

D. W. Wilson has been named as sales representative for S. G. Taylor Chain Co. Mr. Wilson will assist the manager of the firm's special products division of the Pittsburgh, Pa., sales office. Mr. Wilson will serve industry throughout Pennsylvania, New York, New Jersey, Maryland, Delaware, West Virginia and Ohio.

Dr. Lawrence D. Schmidt was appointed director of research for Semet-Solvay and Wilputte coke oven divisions of Allied Chemical and Dye Corp. Dr. Schmidt succeeds **William Tiddy** who recently retired. With the U. S. Bureau of Mines for 18 years and head of the Bureau's Morgantown, W. Va., experiment sta-

Industrial Cut Gears

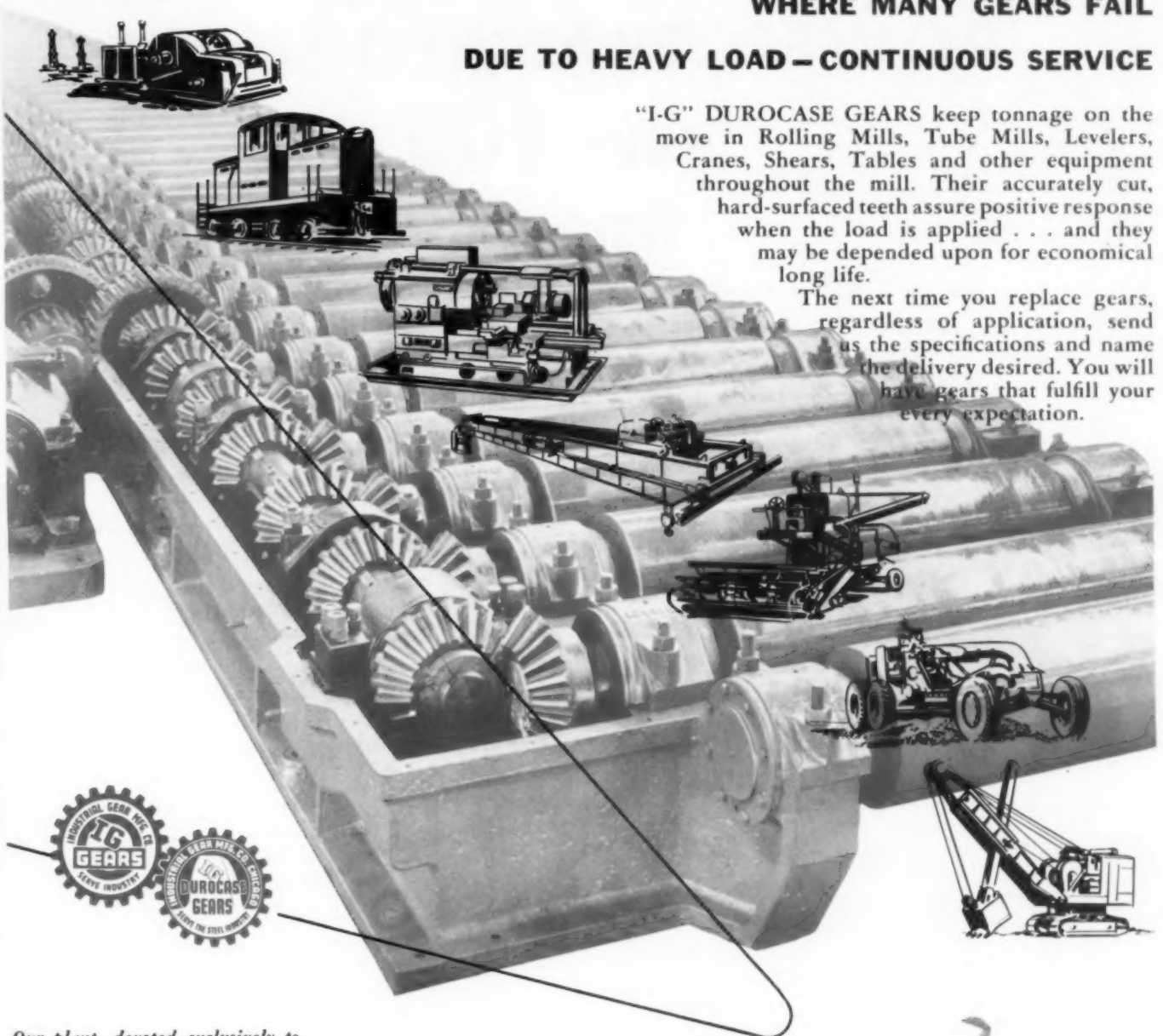
FOR THE TOUGH JOBS

WHERE MANY GEARS FAIL

DUE TO HEAVY LOAD—CONTINUOUS SERVICE

"I-G" DUROCASE GEARS keep tonnage on the move in Rolling Mills, Tube Mills, Levelers, Cranes, Shears, Tables and other equipment throughout the mill. Their accurately cut, hard-surfaced teeth assure positive response when the load is applied . . . and they may be depended upon for economical long life.

The next time you replace gears, regardless of application, send us the specifications and name the delivery desired. You will have gears that fulfill your every expectation.



Our plant, devoted exclusively to gear and sprocket cutting, can be visited pictorially through Bulletin No. 152-A. Write for your copy—and see how well equipped we are to handle your needs.

MEMBER OF AGMA

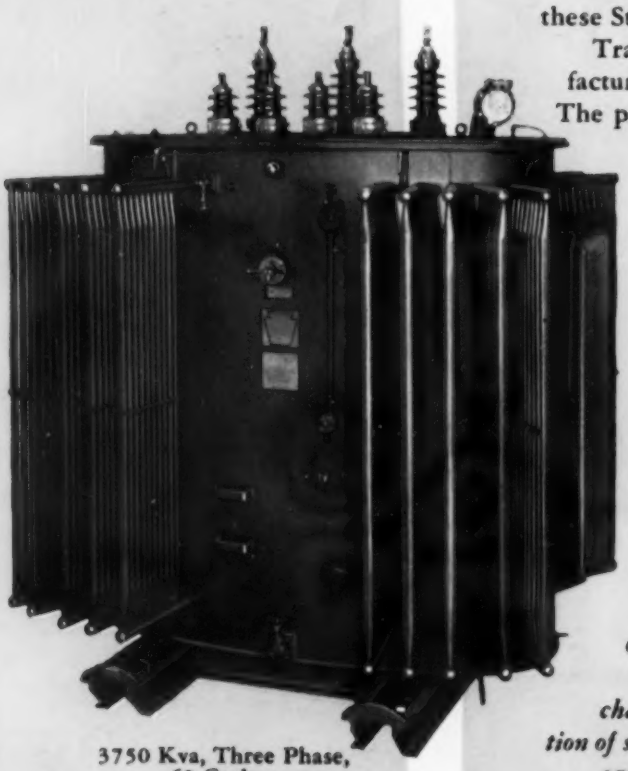
Industrial Gear Mfg. Co.

4527 W. VAN BUREN ST.
CHICAGO 24, ILLINOIS

PENNSYLVANIA
Standard Parts
POWER TRANSFORMERS
save YOU
time and money . . .

this transformer saved the purchaser

$1196



3750 Kva, Three Phase, 60 Cycles.
34,400△-4360Y/2520x 8720Y/5040 volts.

Here's another example of money saved and a quick delivery made on a 3750 Kva transformer that qualified as a Pennsylvania Standard Parts Power Transformer. Today, more than ever before, purchasers are recognizing the advantages of ordering transformers that conform to ASA Standards C57.12a. (Transformers covered by these Standards are similar to the Standard Parts Power Transformers that Pennsylvania has been manufacturing for 6 or 7 years.)

The primary advantage of Standard Parts Power Transformers is the fact that savings up to 8% are possible, even if requirements are not quite standard but are within the limits of the C57.12a Standards. That is because the Standard Parts transformer has liberalized high voltage ratings, which give the purchaser an opportunity to buy a standard transformer that meets the specific requirements of his System.

However, if the purchaser desires optional features such as current transformers, disconnect switches, etc., he may obtain them at regular prices and without any price penalty being added to the base price of the Standard Parts transformer.

Standard Parts Power Transformers are available in single phase sizes up to 5,000 Kva, 69 Kv; and three phase sizes up to 10,000 Kva, 69 Kv. Standard Parts Power Transformers can be purchased at worthwhile savings because of quantity production of standard parts produced with adequate tools and equipment. This has improved the quality of the workmanship, reduced the possibility of errors, and permitted more rigid inspection during the various stages of production.

PENNSYLVANIA TRANSFORMER COMPANY
A McGraw Electric Company Division • **Canonsburg, Pa.**

tion since 1946, Dr. Schmidt has pioneered in the development of new processes for the gasification of coal.

Donald L. Peterson, has been named to the Cleveland, Ohio, district sales office, of Reliance Electric and Engineering Co., 13967 Cedar Road. **David H. Rush,** was appointed to the Buffalo, N. Y., district sales office, 445 Ellicott Square Building. **John E. Harger,** joins the Detroit, Mich., district sales office, 12326 Hamilton Avenue.

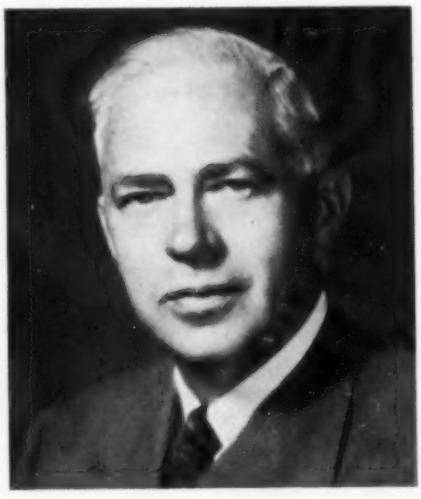
Ralph Eads, Jr., of the Eads Co., 4604 S. Main, Houston, Tex., has been appointed Askania Regulator Co. representative in Texas and Louisiana. Mr. Eads succeeds the late **Dean D. Ault** of Houston, who was recently killed in an airplane accident.

Robert C. Brady was named as New York, N. Y. office manager for Farrel-Birmingham Co., Inc., succeeding **Carl ter Weele** who has left the company. Mr. Brady is located in the Chrysler Bldg., New York.

Donald K. Schleiffarth has been named St. Louis, Mo., representative for Chas. Taylor Sons Co. Mr. Schleiffarth succeeds his father, **A. O. Schleiffarth,** who died July 7.

Obituaries

Davis H. Tuck died July 5. Mr. Tuck was associated with the Holophane Co. from 1917 to the time of his passing. He was a director of the company and until 1951 was chief electrical engineer, and for the past two years was active on a consultant basis. He was chiefly



DAVIS H. TUCK

interested in the improvement of industrial lighting equipment and plant lighting design. He had many patents issued to him on industrial lighting equipment and measuring instruments, and was the author of numerous papers covering industrial lighting application. Davis H. Tuck was a graduate of the Massachusetts Institute of Technology, 1911, B.S. in electrical engineering, and from 1912 to 1915 was with the National Bureau of Standards at Washington, D. C. in the Photometric Laboratory and while there originated the "Multivoltage Technique of Standardizing Tungsten Filament Lamps against the Primary Carbon Lamp Standards."

Chester A. Matirko, former assistant works engineer of Basic Refractories, Inc., died in Chicago, Ill., on June 30.

Fred Comstock Boyce, 84, chairman of the board, D. J. Murray Manufacturing Co., Wausau, Wisc., died June 28.

Armin O. Schleiffarth, St. Louis, Mo., manufacturers' representative, died July 7 at his home in nearby Webster Grove, Mo. Mr. Schleiffarth had been the St. Louis representative for Chas. Taylor Sons Co., subsidiary of National Lead Co.

Norman J. Urquhart, 62, died July 27 at Pittsburgh, Pa. Mr. Urquhart had been employed for 12 years by the Steel Processing Co., a subsidiary of the Fort Pitt Bridge Co. as a consulting combustion engineer.

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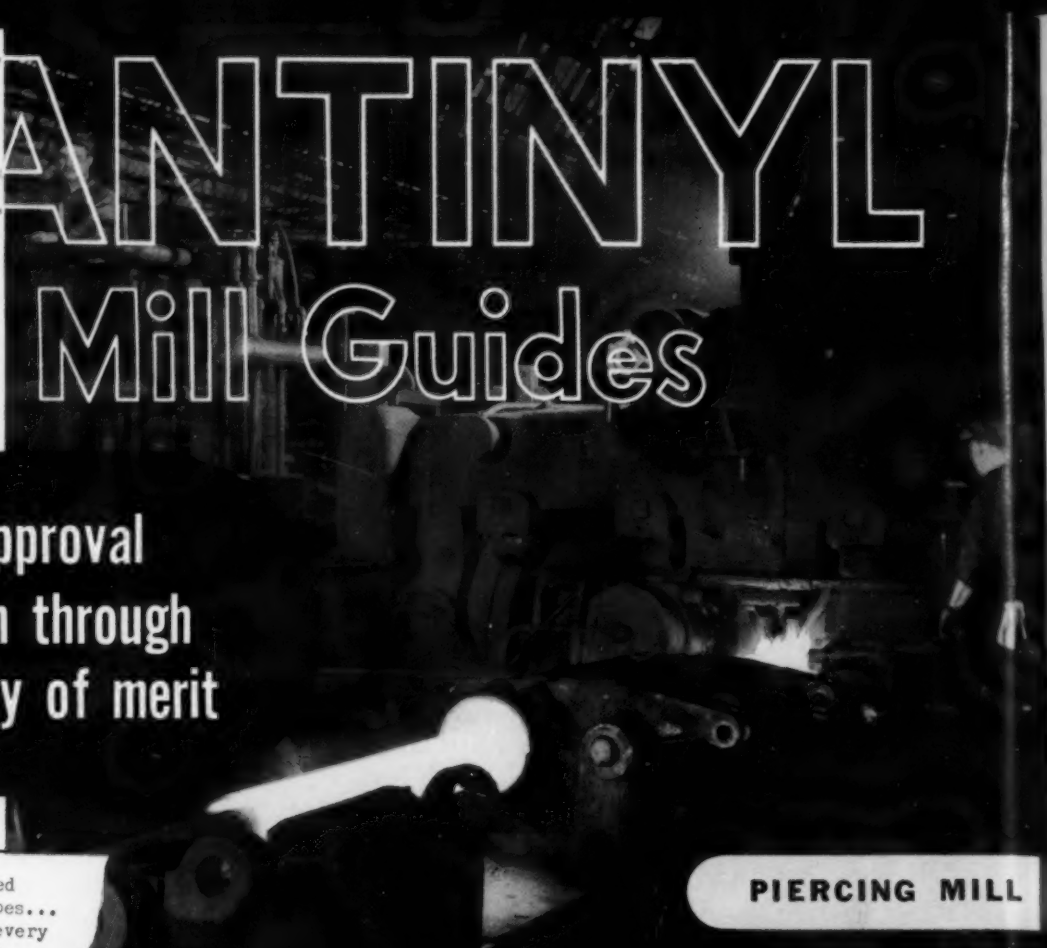
TRANTINYL Tube Mill Guides

. . . have won the approval of tube mill men through a quarter-century of merit



PIERCING MILL

"When our Seamless Mills were started 20 years ago, the ordinary guide shoes... had to be changed several times in every 24 hours... a problem that had to be overcome to prevent excessive delays..."

"Youngstown Alloy Casting began the manufacture of piercer guide shoes (later given the trade name "Trantinyl") which proved so successful in our piercing mill operation that we have used them exclusively ever since."

"TRANTINYL GUIDES THE STEEL INDUSTRY"

"Guide shoes in a Mannesmann piercing mill are subjected to severe punishment and heat, but our experience has been that a single set of "Trantinyl" alloy guides will stand up in our mill during the piercing of as many as 20,000 hot steel billets."

"Instead of being changed frequently, they will remain in the mill in good condition for as long as one to two weeks at a time. We have never been able to find another guide shoe that will equal this..."

"From time to time we have tried out samples from other manufacturers, but the performance of the "Trantinyl" is so superior that there is no comparison."

"We feel rather kindly toward Youngstown Alloy Casting Corporation because of the quality of the products they have furnished us, which have contributed much toward our success in overcoming mill delays, and toward our success in manufacturing Seamless Tubing of a very high quality."

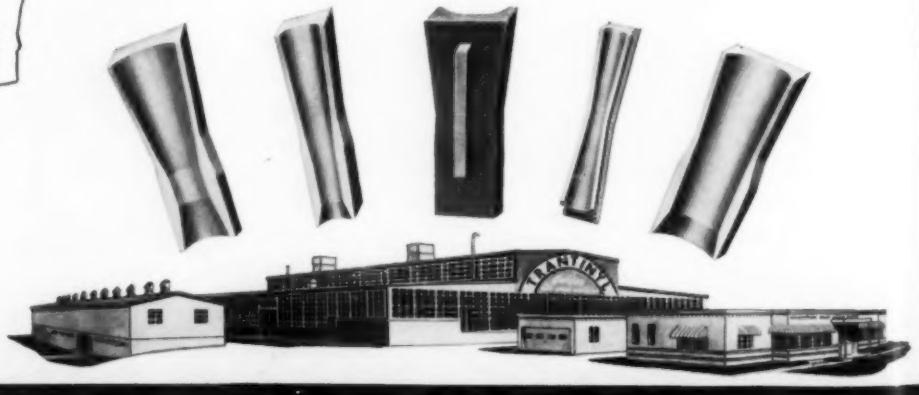
SEAMLESS TUBE MILLS: guide shoes, rolling mill plugs and rolls, piercer points

ELECTRIC WELD TUBE MILL: forming rolls, planishing rolls, tool holders, etc.

ROLLING MILLS: bar, hoop, strip, shape mill guides; and rollers

STRAIGHTENING MACHINE GUIDES • HEAT RESISTING CASTINGS

"TRANTINYL No. 1" CAST TO SHAPE

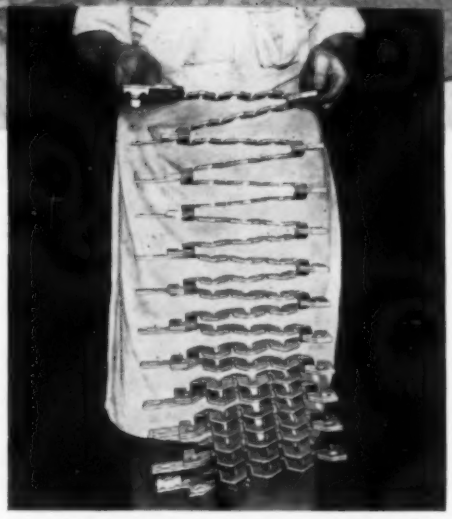


Youngstown Alloy Casting Corp.

Youngstown, Ohio

Simplified TAP Shifting

1. When Improving Motor Operation
2. Making it Easier to replace Sections
TAB WELD
PLATE RESISTOR
THE ELECTRIC CONTROLLER & MFG CO.



This illustration shows how welding provides a continuous path throughout each section to:

1. Stabilize the resistance value.

2. Eliminate trouble in concealed areas.

EC&M TAB-WELD Resistors do *not* depend upon *occasional* tightening of end-clamping nuts *to prevent burning at grid-eyes or at tap-plates.*

★ It's often advantageous to shift taps on a resistor section after installation to improve motor performance. It's equally advantageous, when replacing a section out in the mill, to pick a standard section from the storeroom shelf and use it *without disturbing the grid-assembly*.

These operations are easy to perform with EC&M TAB-WELD Resistor Sections because tap-plates are fixed in position. Only the terminal block, bolt, and lead are moved. The tap-marking tag moves with the bolt.

For lower up-keep, prolonged life, and easier maintenance, use EC&M Bulletin 942 TAB-WELD Plate Resistors, made from *corrosion-resistant* steel.

THE ELECTRIC CONTROLLER & MFG. CO.
2698 EAST 79TH STREET • CLEVELAND 4, OHIO

How TIMKEN® bearings help keep production costs low on a 4-high mill

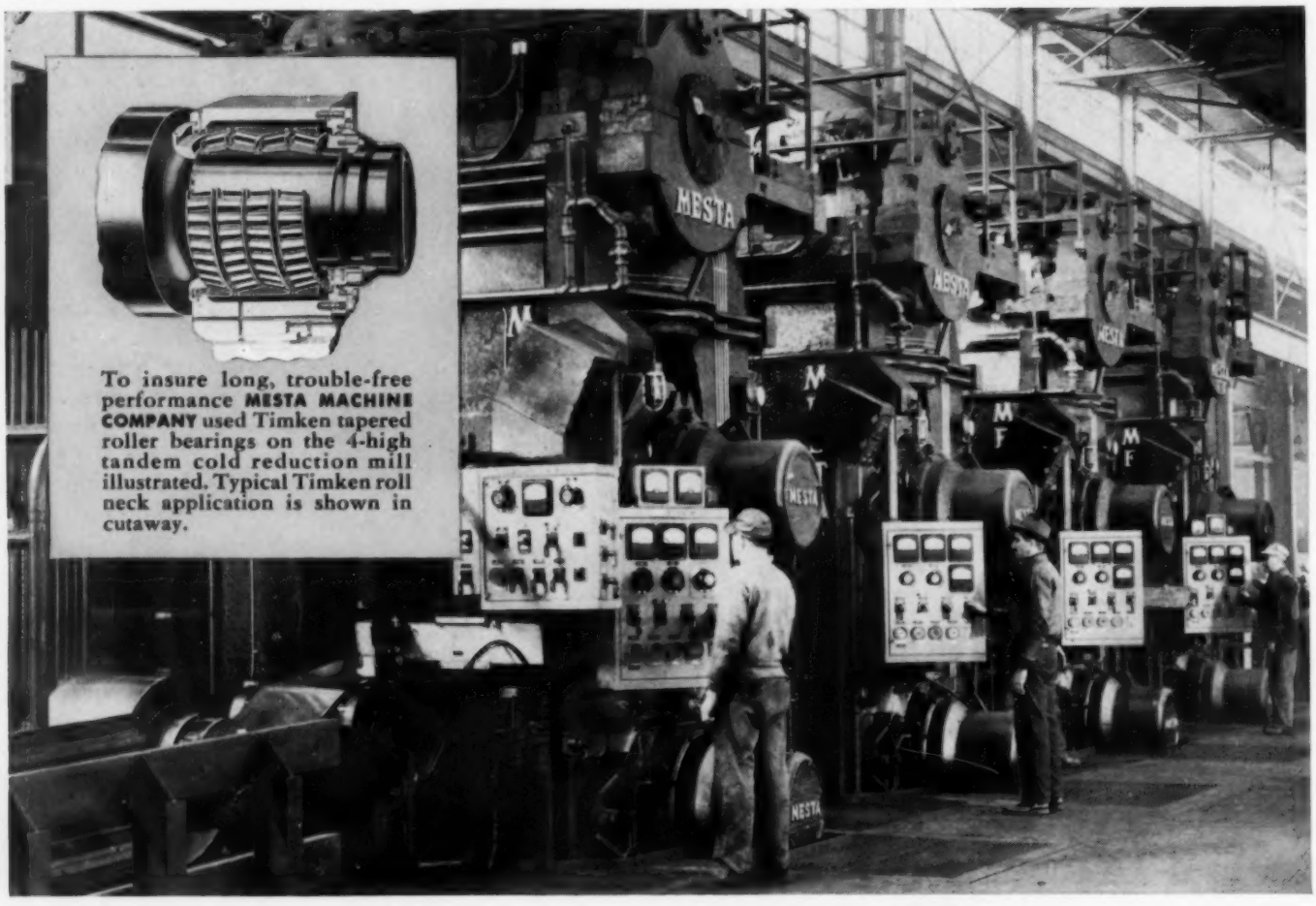
FEWER time-outs for repair and maintenance mean lower production costs. That's why the work roll, feed reel, tension reel and pinions of this Mesta 4-high tandem cold reduction mill—now in operation at Allegheny Ludlum's West Leechburg plant—are mounted on Timken® tapered roller bearings.

Timken bearings' tapered construction takes all radial and thrust loads in *any* combination. Line contact between rollers and races gives Timken bearings extra load-carrying capacity.

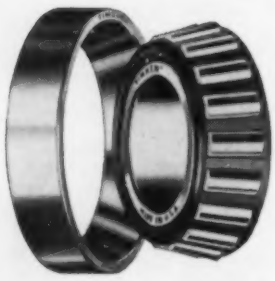
The true rolling motion and extremely smooth surface finish of Timken bearings practically eliminate friction. Shafts and housings are held concentric, closures made more effective. Lubricant stays in —dirt and moisture stay out.

Years of research and development by the Timken Company have resulted in many improvements in roll neck bearing design and performance. For more information about Timken roller bearing applications, write The Timken Roller Bearing Company, Canton 6, Ohio. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.



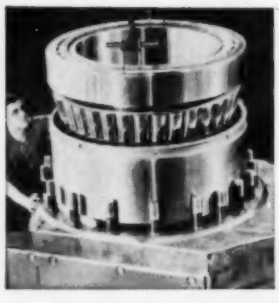
To insure long, trouble-free performance **MESTA MACHINE COMPANY** used Timken tapered roller bearings on the 4-high tandem cold reduction mill illustrated. Typical Timken roll neck application is shown in cutaway.



TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS



ROLL NECK BEARING ENGINEERING SERVICE

Our field and service engineers have had years of experience with problems of roll neck bearing design and operation. They'll help you select bearings and design mountings. The Timken Roller Bearing Company is the acknowledged leader in: 1. advanced design; 2. precision manufacture; 3. rigid quality control; 4. special analysis Timken steels.

NOT JUST A BALL ○ NOT JUST A ROLLER ⬭ THE TIMKEN TAPERED ROLLER ⬭ BEARING TAKES RADIAL ↓ AND THRUST →◎← LOADS OR ANY COMBINATION →◎←

Equipment News...

FLAME CUTTER

▲The Milwaukee Shipbuilding Corp. has placed on the general market the first "three-dimensional" flame cutting equipment for scarfing the edges of curved metal pieces in preparation for welded assembly of larger units.

The method opens the door for designing increased strength into curved metal structures made up of welded parts which themselves are curved. The semiautomatic equipment speeds up and makes more uniform the preparation of welding joints, in comparison with previous hand held flame torch methods of scarfing curved pieces.

Last year a major defense agency was so eager for fast, sure equipment to prepare the edges of curved pieces that the Milwaukee firm designed and made the first working model of its equipment in a week. Application has been made for patents.

Initial production of more than 80 units has been absorbed for manufacturing of curved welded metal parts for armed forces equipment. That demand now has been met and Milwaukee Shipbuilding finds itself with a substantial addition to its original line of bore grinders.

Milwaukee Shipbuilding calls the flame cutting equipment "three-dimensional" because it operates vertically, horizontally and at angles from the first two as it scarfs the edges of curved metal pieces. The third dimension is the operation of the cutting equipment around curves.

The third dimension has invaded the metal industry in the form of flame cutting equipment which cuts vertically, horizontally, and at angles from the first two as it scarfs the edges of curved metal pieces. A unique roller arrangement keeps the orifice of the cutter head in exact position no matter what the angle.

In this way it is a departure from previously developed semiautomatic flame cutters which operate vertically and horizontally in two dimensions only as they scarf the edges of flat metal.

The original application of the equipment was in production of curved sections for armed forces tank hulls. At one time the edges of the sections were scarfed with hand held equipment, but the method was slow, several hundred per cent slower than the semiautomatic "3-D" method, and open to deviations from the desired angle.

The new equipment centers on a flame cutter which moves under power as it follows the curves of the metal under process. The cutting flame slants at a constant angle from the desired apex of a scarfed edge. Devised was a system of twin rails whose rise, fall, tilts and turns match those of the metal under process. Four spring loaded drive rollers and a spring loaded idler roller keep the moving unit true to the path of the rails. The drive rollers move at speeds up to 15 in. per min, powered by a 1-25th hp electric motor. The speed range can be varied to suit customers' needs. One of the rollers in the drive group is serrated to prevent slippage when the unit enters a curve, where control must be absolute if deviations are to be avoided. The serrated roller cuts its own track in the guide rail which it follows.

Spring pressure from within the moving unit which also carries the motor in its sealed aluminum case, keeps the four drive rollers pressed snugly against the lower or inside rail. This rail is closest to the metal in process and from its center to the apex point a constant distance is maintained. The fifth roller — the idler—presses against the upper or outer rail, which serves as a stabilizer. The fifth roller also has another function. It joins with the serrated roller and a drive roller which lies between the serrated and fifth rollers to keep the orifice of the cutter head in exact position.

The centers of the rollers are lined up with the desired position of the orifice when the equipment is built. The three rollers in effect are the moving unit's front wheels, whose "axle" is aimed at the apex point with the help of the tilt of the rails at curves. All the rollers except the serrated roller are concave to fit the rounded surfaces of the rails, which they grip from the sides under spring pressure.

Projecting inward toward the metal being scarfed from the moving unit is a sector on which the flame cutting head itself is mounted. The sector curves over the edge being scarfed so that the head may be set at any of the angles the job may require. The center of the sector is the apex point of the work. However, the movement of the head on the sector does not destroy the constant relationship of the apex and the center of the guide rail. Stops on the sector speed up the adjustment of the angle of the head for scarfing first one side of the edge, then the other, although arbitrary changes in the angle within the limits of the stops can be made. The maintenance of the constant relationship of the apex and the rail results in angled edges whose peaks will invariably meet peaks in other edges of curved metal to which they will be welded. This maintenance of a stable apex point speeds up production and cuts down waste, company officials say, and tolerances of $\frac{1}{32}$ in. can be maintained.

TELEMETER UNIT

▲ A new multiplexing transmitting and receiving system for use with the company's "Metameter Telemeters" has just been announced by Bristol Co. With this equipment up to 15 readings (either pressure, vacuum, water or liquid level, flow, temperature, static and differential pressure, motion, voltage, current, and totalized load) taken at separate locations or areas can be transmitted any distance to receiving instruments over a single circuit. This results in a saving in the cost of circuits since it eliminates the need of separate circuits for each readings transmitted. Readings can be transmitted over telephone circuits, carrier current, radio including microwave,

THIS PICTURE TELLS A STORY of a new cost-cutting opportunity for steel mills

Note the ready accessibility of each item of steel in this storage yard of a well-known steel mill. It's this availability of materials that's one of the prime advantages of the ROSS STRADDLE CARRIER handling method . . . an advantage, unmatched by any other method, that eliminates delays, lowers costs and increases the production efficiency of the mill.

ROSS STRADDLE CARRIERS, heart of the Ross unit-load handling system, are built to handle 45,000-pound concentrated loads on around-the-clock schedules in the roughest, toughest steel mill service . . . to put those loads *where* wanted *when* wanted.

Your mill, too, can profit by this modern, flexible mass handling system. Get in touch with Ross today for the complete details.

Rely On ROSS

THE ROSS CARRIER COMPANY

Direct Factory Branches and Dealers Throughout the World

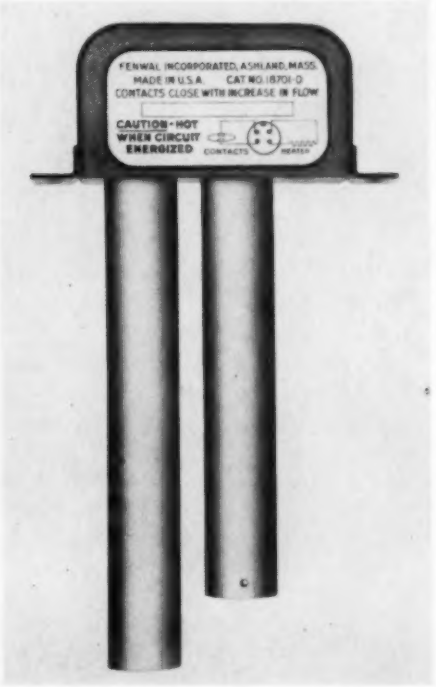
400 MILLER ST., BENTON HARBOR, MICH., U.S.A.

VHF, and UHF, private wires, and low rental cost telemeter circuits (15 CPS channels) available from the telephone company.

FLOW DETECTOR

▲ A new precision flow detecting instrument, called the "Detect-A-Flo," designed to sense and respond to changes or stoppages in the flow of air has been developed by Fenwal Inc.

Originally developed to prevent high-capacity aircraft heaters from overheating if their air intakes become clogged, the instrument can be used as a warning device in air-cooled equipment, a ventilation control, and for similar applications where a particular flow rate must be maintained. It may also be used as a liquid-level detector or controller in storage and supply tanks. Viscous fluids, which sometimes affect the accuracy of float type units, have little or no effect on the operation of the instrument. Highly accurate level detection is obtained since the unit responds to a change of less than 0.1 in. in liquid level.



The instrument can be set to respond to any mass rate of flow air in the approximate range of 1000 to 50,000 lb per hr per sq ft. This range corresponds to less than 4 ft to more than 180 fps for flows of standard air.

The unit is easy to install and practically foolproof in operation. It is inserted directly in the duct line or tank being monitored, thus eliminat-

Oil Immersed

ROWAN TYPE 800--834 LIGHTING SWITCH

"First choice" for locations where operating requirements are severe and atmospheric conditions dusty, corrosive, or semi-hazardous. Enclosures are designed to meet the requirements of NEMA Type XI, welded construction—fabricated from high quality, cold rolled steel sheets with threaded conduit openings. Simplicity of operation—easy to inspect since the entire mechanism and terminals are readily accessible.

Extra heavy, self-aligning, quick make and quick break, renewable contacts are series break which minimizes concentration of burning. Rowan time-tested AIR-SEAL fuses provide dependable short circuit protection.

Representatives in all principal cities throughout the United States.

Type 800 for use on 3-wire, single phase 115/230 V. circuits.

Type 834 for use on 4-wire, 3 phase, 120/208 V. circuits.

These units are available in 6 and 12 gang units.

ROWAN CONTROL

THE ROWAN CONTROLLER CO., BALTIMORE, MD.

ing lead lines, auxiliary fittings, and related condensate or clogging problems. It does not depend on a pressure drop for its operation, thus avoiding a costly, continuous energy drain on the moving stream. The unit has no moving parts and preserves the smooth flow of the monitored stream. Furthermore, the instrument is unaffected by vibration, is repeatable, and is hermetically sealed. Hermetic sealing permits the instrument to be used in virtually all types of service without endangering reliability or sensitivity, and without maintenance difficulties.

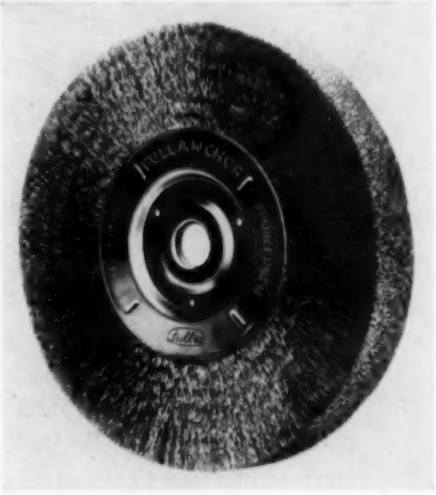
The instrument operates on the principle that the amount of heat conducted away from a constant heat source varies with the rate of flow of air moving past that surface. One leg of the unit is continuously heated by a small internal heater. As the flow rate drops, the heated leg expands because less heat is conducted away. The resulting expansion is transmitted through lever action to a strut-and-electrical contact assembly in the other leg. This motion relaxes the tension in the struts and causes the contacts to move apart, thus breaking the circuit. This contact action is similar to that used in the basic Thermoswitch unit, a precision thermostat also manufactured by Fenwal. A regular contact action, whereby the circuit is broken when the fluid-flow exceeds the desired rate, will also be available.

Because of the "two-legged" design, the unit compensates inherently for any change in ambient temperature within its operating range, at present, —65 F to +175 F. The instrument therefore retains its accuracy in either a constant or changing ambient temperature. Operating sensitivity at room temperature is less than 0.25 fps at low flows and less than 1 fps at the higher flows.

The maximum dimensions of the unit are approximately 2 by 2¼ by 5¼ in.; weight is approximately 8 oz. The heater draws 35 watts at 28 volts a-c or d-c; a 115 volt model will also be available. The control can handle 5 amp at 115 volts a-c or 2 amp at 28 volts d-c. The unit will be made with either a terminal block screw or a standard AN connector.

WHEELBRUSH

▲A wheelbrush of new design which provides longer brush life, improved performance, increased maximum wheel speeds, insured balance and extra safety at no increase in cost, is now being produced by the industrial division of the Fuller Brush Co., it has been announced. The tool can be



used either singly or in multiple units in any of the many industrial applications where wheelbrushes are adaptable.

Features of the wheelbrush, called "Fullanchor," stem from the new design. As the trim wears down, larger sideplates can easily be exchanged for smaller ones, thus exposing a new length of trim and greatly increasing the life of the brush. Brush balance is acheived by clamping an almost identical number of filaments in each tuft, then anchoring each tuft to the core with evenly spaced heavy wire staples driven through a continuous steel channel. This uniformity of fill keeps brushes to a closer balancing tolerance than government standards require.

Shifting of the fill material at high speeds is prevented by the staple anchoring system, since each filament is looped under the staple to prevent its pulling out. These factors of exceptional balance and fill anchoring not only lengthen the life of the tool, but also increase personal safety, since chances of the brush throwing filaments or disintegrating from centrifugal force at high speeds are greatly reduced.

Filament fatigue, or breakage, a major cause both of wear and "flying filaments," is reduced with this brush because the new design eliminates the usual single flexing or stress point

Enterprise 78-In. CRANK PIN TURNING MACHINES

These machines turn large Diesel and gas engine crankshafts while holding them off center. Dual carriages permit double cutting simultaneously.

ALSO AVAILABLE IN 36-IN. SIZE.

Write for Bulletin 302

ESTABLISHED 1878

THE ENTERPRISE COMPANY
MACHINERY BUILDERS & ENGINEERS
SUBSIDIARY OF WM. K. STAMETS COMPANY—PITTSBURGH
COLUMBIANA 1, OHIO, U. S. A.

Amazingly simple way to measure BLAST AIR DEW POINT

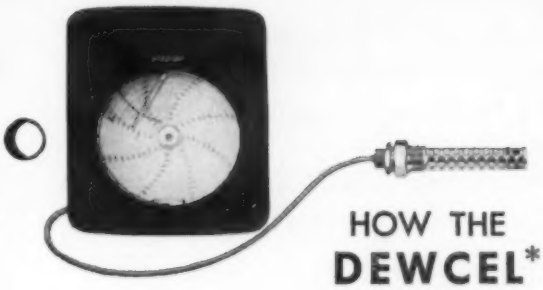
directly . . . accurately . . . continuously

Now you can measure or control the moisture content of blast air with simplicity and accuracy never before obtainable!

The unique Foxboro Dewcel*, an entirely new type humidity-sensitive element, has made this possible, at surprisingly low cost. Coupled with a Foxboro Recorder or Controller, the Dewcel offers these outstanding advantages:

1. Direct recording in dew point temperature, at existing pressure.
2. Wide working range — even operates at sub-zero temperatures.
3. Neither adds nor removes water from atmosphere.
4. No water box or circulation of air required.
5. Simplicity that eliminates maintenance.
6. High sustained accuracy.
7. Initial and operating economy.

Investigate Foxboro Dew Point Control. Write for Bulletin 407, and for Engineering Data Sheet 330-1 covering moisture control for furnace air blast. Foxboro Engineers will be glad to discuss the application of this control to your furnaces, at your convenience. **The Foxboro Company, 588 Neponset Avenue, Foxboro, Mass., U.S.A.**



HOW THE DEWCEL* WORKS

The Dewcel element is a thermometer bulb (liquid-filled or electric-resistance type) jacketed with lithium-chloride-impregnated woven glass tape. Over this are wound two spaced gold or silver wires connected to an AC source. The lithium chloride absorbs moisture, allowing current to flow, generating heat, and raising the temperature. Equilibrium temperature is reached when vapor-pressure of the moist salt exactly balances that of the surrounding air or gas. The System translates this temperature into direct readings of dew point.

Thus, Foxboro Dew Point Instruments give direct readings or control of dew point from —50°F. to 142°F. at working temperatures from —40°F. to 220°F. Readings easily converted to absolute or relative humidity.

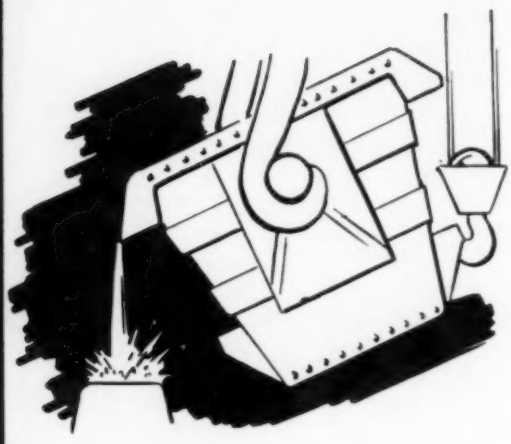
*Trade Mark

FOXBORO
REG. U. S. PAT. OFF.

RECORDING · CONTROLLING · INDICATING
INSTRUMENTS

FACTORIES IN THE UNITED STATES, CANADA, AND ENGLAND

Walsh Missouri-Quality Refractories Used in Open Hearths of YOUNGSTOWN SHEET and TUBE COMPANY, Indiana Harbor, Ind.



Walsh Refractories Corporation, for over 50 years manufacturers of high grade refractories, takes justifiable pride in the fact that its products have been installed in the new open hearth furnaces of Youngstown Sheet & Tube Company's Indiana Harbor works.

Walsh Missouri-Quality Refractories have helped to bring efficiency and economy to industries throughout the world. Each time-tested brand of Walsh fire brick is an investment in greater production... lower cost... the result of careful selection of raw materials, advanced methods of manufacture and better research and ceramic engineering.

Walsh Insulating Castable Refractories High Temperature Cements · Plastic Fire Brick · Other Special Ramming Mixes

Five Great Names in Steel Industry Refractories

WARCO XX—High Heat Duty Fire Brick. Dry Press Process, Tunnel Kiln Burned.

MULLITEX — Super Duty Fire Brick, Dry Press Process, Tunnel Kiln Burned. 100% Missouri Clays.

WR LADLE BRICK—High Refractory. Dry Press Process, Tunnel Kiln Burned.

MULLITEX HB — High Burn Special Super Duty Fire Brick, Tunnel Kiln Burned. 100% Missouri Clays.

APEX — Extra Duty Stiff Mud Deaired Fire Brick.

WALSH REFRACTORIES CORPORATION — America's Best Clays

WALSH REFRACTORIES CORPORATION

101 Ferry Street • St. Louis 7, Missouri

For over 50 years manufacturers of high grade refractories

by distributing it over a longer filament area. Also, compared to conventional wheelbrushes in its price bracket, the new brush contains 20 to 40 per cent more fill material per brush. This added material provides a denser brushing surface, which results in faster cutting action, better finishes and longer brush life. The comparatively low price is possible because of manufacturing economies inherent in the design.

Design also contributes to the increase in safe maximum wheel speeds, which are substantially in excess of almost every comparable wheelbrush now in use. The jointless steel core, the measured looped filaments, plus the uniform weight and balance of brush material gives greatly increased resistance to disintegration at high speeds. Extensive tests have shown that the 8-in. wheelbrush, for example, will withstand at least 8000 rpm before disintegrating. This is well over twice what conventional wheelbrushes are expected to stand under ordinary circumstances.

The new wheelbrush comes in 6 in., 8 in., 10 in. and 12 in. sizes, filled with wire of oil tempered, high tensile, crimped or stainless steel, brass or nickel. The wire material comes in commonly-used gauges. All brushes may be used off-hand, mounted on flexible shafts, fixed on brushing machines, lathes and motors, or ganged on special machines when a wide brushing surface is required.

TRUCK CRANE

▲ A new highly-mobile truck-crane, designated as the Pitman Crane Model 80 has been introduced this month by the Pitman Manufacturing Co.

Capacity up to four tons on a 25-ft boom, with additional boom lengths up to 59 ft are features of the new crane, which is designed for installation on trucks 2½ tons or larger.

Precision operation, ability to use the truck it is mounted on for more than a single purpose, quick set-up time, ease of control; these are additional features of the new Pitman crane.

Key to the precision operation of the crane is versatile loadline winch which can be operated either power-up and power-down or free-spooling. This allows the operator either to let the load down under full power or to slip it down as fast as he wants with a foot brake.

Precise boom action is afforded by (1) a power-up and power-down topping winch, which raises and lowers the boom, and (2) a double-acting hydraulic cylinder which swings the boom in a 180-degree arc. Maximum capacity loads can be topped with the boom.

Perhaps one of the most outstanding features of this crane is that a fifth wheel can be installed on the crane's sub-frame on a long wheelbase truck, allowing the owner to use the same truck on which the crane is mounted to haul a trailer. In so doing, the owner has a dual-purpose piece of equipment: a versatile, highly-mobile truck crane, plus a tractor to haul a semi-trailer.

Standard boom length of the crane is 25 ft. Inserts are available for additional boom lengths of 37 ft, 48 ft and 59 ft. Maximum ratings for these boom lengths are: 25 ft, 8,000 lb; 37 ft, 6,000 lb; 48 ft, 3,000 lb; and 59 ft, 1,000 lb.

With the 25-ft and 37-ft booms, it is possible to set-up the crane for work, or ready it for road travel, in only five minutes. This is possible because the 25 and 37-ft booms are hinged on the side and can be folded and unfolded like a carpenter's rule.

Controls for the crane are situated outside the truck cab, alongside the crane's main "A" frame. The loadline, boom topping and boom swing are controlled by three easy-to-operate levers directly in front of the operator.

GEARMOTOR UNITS

▲ Elliott Co., Crocker-Wheeler Division, has introduced a new line of gearmotors featuring a wide selection of compact, integral power units with single (780 to 280 rpm,) double (230 to 45 rpm) or triple (37 to 7.5 rpm) speed reduction.

These units are available with any Crocker-Wheeler motor—a-c, squirrel-cage, wound rotor, d-c or multi-

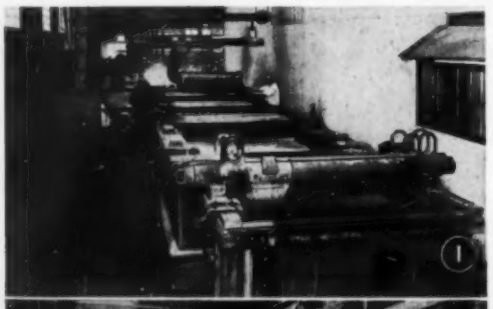
"... As I see it, the new Mathews Loadstar Trolley is just the thing for this job."

● There is a lot of that kind of talk these days about this rugged newcomer to the 4" trolley conveyer field. Over a period of five years *Mathews* engineers have developed this new top-quality precision wheel, the No. 4207 *Loadstar*, for those conveying jobs which demand unusual stamina. Your nearby *Mathews* representative has full information on this high-quality trolley. Have him tell you about it and write today for Bulletin LS-1 announcing and describing it in detail.

MATHEWS CONVEYER COMPANY
Engineering Offices or Sales Agencies in Principal American and Canadian Cities
GENERAL OFFICES
Mathews Conveyer Company . Ellwood City, Penna.
PACIFIC COAST DIVISION
Mathews Conveyer Company West Coast San Carlos, California
CANADIAN DIVISION
Mathews Conveyer Company, Ltd., Port Hope, Ont.

AMERICAN CHEMICAL PAINT COMPANY
AMBLER PENNA.

Technical Service Data Sheet
Subject: EFFICIENT PICKLING WITH RODINE®

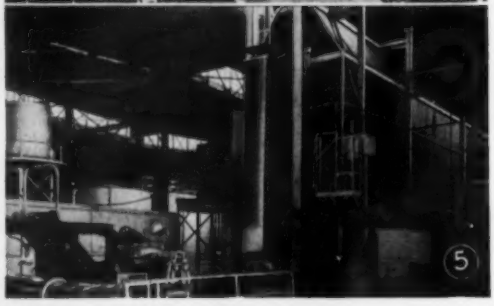


1. Rod and wire are pickled clean with "Rodine" without wasting either acid or metal. Breakage in drawing due to acid brittleness is minimized.

2. "Rodine" protects the exterior of tubes while completely descaling the interior and minimizes breakage in drawing due to acid brittleness.

3. "Rodine" makes possible the batch pickling of sheets over a wide range of acid concentration and temperature.

4. Whether sheet steel is pickled continuously or in batches, "Rodine" improves the surface and prevents "pickle burning" in prolonged pickling.



5. The absence of pitting and the smoother surface obtained with "Rodine" saves expensive coating metal in electrolytic tinning and galvanizing.

CHEMICALS ACP PROCESSES

WRITE FOR DESCRIPTIVE FOLDER ON "RODINE" AND INFORMATION ON YOUR OWN PICKLING PROBLEM.

CHEMICALS ACP PROCESSES

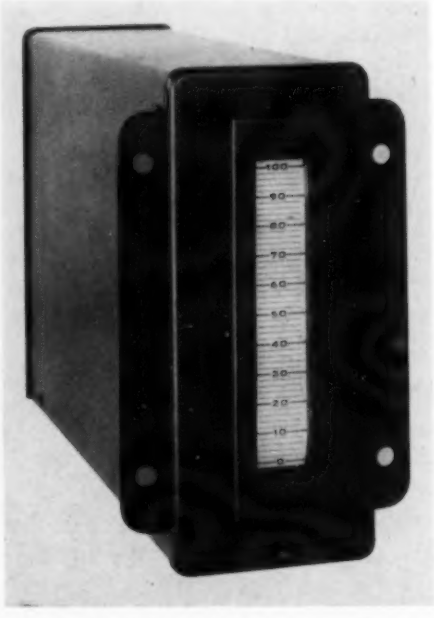
speed, in open-protected, splash-proof, totally-enclosed non-ventilated, totally-enclosed fan-cooled and explosion-proof closures. Frame sizes range from 1 to 150 hp. Mountings may be horizontal, ceiling, sidewall or inclined. Also available is a complete integral power unit with the Crocker-Wheeler disc brake.

A distinctive feature of this new line is the positive oil seal between gears and high-speed bearing which lengthens the bearing life by sealing off abrasive matter. A large oil reservoir provides efficient splash lubrication for the precision-processed, file-hard gears.

Other features include a locked motor shaft pinion to provide positive contact for minimum vibration on reversing service; cast iron pyramidal base for maximum strength, rigidity and prevention of misalignment due to uneven foot mounting; and extra capacity anti-friction bearings for severe operating conditions.

PANEL INDICATOR

▲ A new ribbon-type indicating receiver for graphic panel use has been announced by Foxboro Co. Added to the company's "Consotrol" line of compact instruments, the Model 50



"Consotrol" indicator is especially suited to panel applications which require continuous indication of valve position or variables such as liquid level.

The indicator receives pneumatic measurements from a transmitter located at the process. This force is applied to a sensitive receiver bellows

which, through a lever and stainless steel tape arrangement, rotates two lightweight drums. A brightly colored nylon tape, wound on the drums, is thus drawn behind a glass pane on which scale graduations are printed. The clearly defined readings make internal illumination unnecessary, thus simplifying installation and reducing maintenance.

Since the indicator scale measures only ¾ in. by 4¼ in., the instrument fits easily into graphic panel symbols. All component parts are mounted on a removable chassis and protected by a housing which is secured to the back of the panel. The complete mechanism can be removed from its housing for service without disturbing the scale, case or panel. Zero, range and damping adjustments are then readily accessible.

The instrument is available with single or dual indicating scales and can be adjusted for direct or reverse response to measurement, as desired. Alarm contacts of the mercury switch type are optionally provided to produce various combinations of warning signals, depending on process needs.

BUSWAY PLUG

▲ Getting power from overhead busway to machines below has been made easier and faster by an improved device recently developed by Trumbull Electric Department of the General Electric Co.

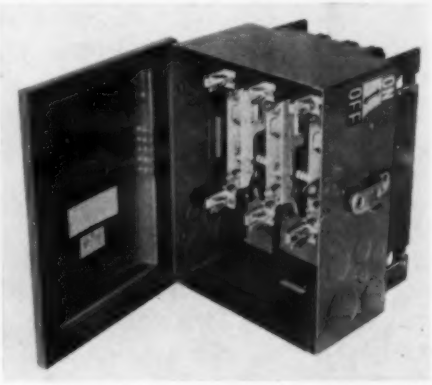
The new device, called an "FG Flex-A-Plug," is designed for use with the Trumbull "Flex-A-Power" distribution system.

Working on the same principle involved in plugging into a wall socket, the new plug taps power from heavy current-carrying busway for machines and other current-consuming equipment.

Installation is made easier and faster by new hanger clips which hold the plug in position while screws are tightened to anchor it firmly to the distribution housing. By actual test, it took an electrician 12 minutes to install the old type plug, as opposed to three minutes for the new FG plug.

Electrically, the new device features the same type of interior used in Trumbull Electric HCI safety switches. This interior operates on the circuit breaker principle of arc interruption. The use of grid pins, magnetic repulsion and other circuit breaker principles to interrupt arcs gives this interior a high momentary current rating, the ability to resist heavy current surges without damage.

Mechanically, the new plug is designed with heavy gage steel side



shields which protect its stabs, the copper prongs which provide the contact with the bus bars. Stabs are further protected by a rugged phenolic shield which encases them. This phenolic shield also provides electrical insulation.

LUBRICATING GREASE

▲ A highly versatile grease which permits the efficient operation of aircraft accessories in ambient temperatures ranging from minus 100 to plus 250 F has been developed by Texas Co. to accommodate the extreme conditions encountered in long-range stratospheric flight.

Based upon the company's pioneer research and development in the field of extended-temperature-operation greases, "Texaco Low-Temp 1888" grease was the first product to bracket the specified range successfully. It is so formulated that for short periods it can function effectively beyond the 250 F temperature specified in MIL-G-7421 (USAF).

The formulation was arrived at from a background of research into aircraft design and operation problems extending back more than 30 years during which time Texaco has maintained a close liaison with all phases of civil and military aviation.

Several years ago the emphasis was on obtaining a grease to give satisfactory performance in the range of minus 65 to plus 175 F. The new grease now extends this range at both high and low temperatures so as to operate satisfactorily in the range of minus 100 to plus 250 F.

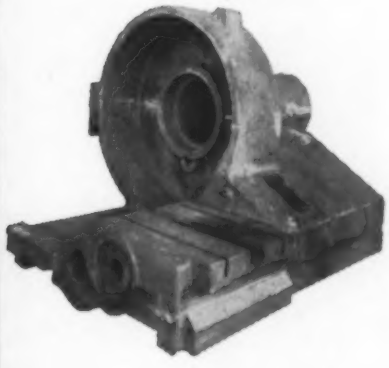
During the decade it has pioneered in developing lubricating greases

Hyde Park

RED CIRCLE Rolls ALLOY-CHILLED

Gray Iron Castings

Castings of any size up to 80,000 pounds. Hyde Park facilities are equal to your every requirement



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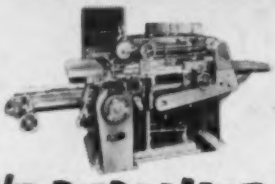
Hyde Park

FOUNDRY & MACHINE CO.
Hyde Park, Westmoreland County, Pa.
ROLLS
ROLLING MILL MACHINERY
GREY IRON CASTINGS



"WE RECOMMEND THIS LUBRICANT TO OUR CUSTOMERS"

—says PACKAGE MACHINERY COMPANY
Springfield, Mass.

"We have found LUBRIPLATE Lubricants to be very effective and use them extensively in our machines. To assure the proper use of LUBRIPLATE Lubricants for re-lubrication, we place tags on our machines before shipment. Thus the purchasers of those machines know the LUBRIPLATE Product we recommend for each application and where to obtain it."

For nearest LUBRIPLATE distributor, see Classified Telephone Directory. Send for free 56-page "LUBRIPLATE DATA BOOK"... a valuable treatise on lubrication. Write LUBRIPLATE DIVISION, Fiske Brothers Refining Co., Newark 5, N. J. or Toledo 5, Ohio.

REGARDLESS OF THE SIZE AND TYPE OF YOUR MACHINERY, LUBRIPLATE LUBRICANTS WILL IMPROVE ITS OPERATION AND REDUCE MAINTENANCE COSTS.

which will perform effectively over an extended temperature range, Texaco found it necessary to replace mineral oil with special "synthetic" oils of low volatility and very high viscosity index. Others have now followed this initial development by providing "synthetic" oils for other lubrication requirements of the jet engine.

The new grease is used to lubricate anti-friction bearings, gears, rolling and sliding equipment having very low motivating power, some types of electronic equipment, instruments, and small actuators where starts at temperatures as low as minus 100 F may be required. This grease has also made a definite contribution to the improved performance of aircraft armament.

WATER HEATER

▲ Pick Manufacturing Co.'s instantaneous water heaters have come into wider use in the iron and steel industy in the past three years. Installations are in operation at mills belonging to U. S. Steel, Bethlehem and Jones & Laughlin. The most recent installations have been made at the new Fairless works of United States Steel Corp., Morrisville, Pa. These installations supply hot water for electrolytic timing, electrolytic cleaning, continuous annealing, pickling, oil interception and preciptron washing.

The heater is designed to supply hot water on a start and stop basis or a continuous flow basis with a minimum temperature variation. Ease of cleaning and maintenance reduce down time to minimum.

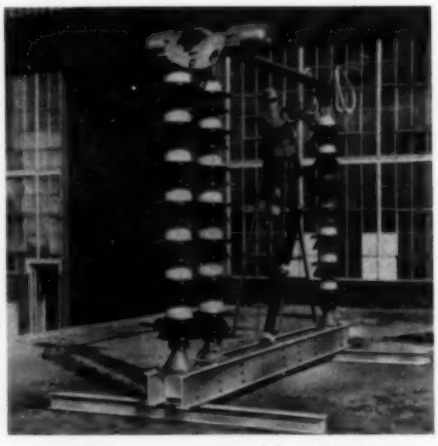
BOILER PIPING

▲ Boiler room piping at Greater Fort Worth International Airport, Tex., emphasizes the care exercised by architects and engineers in safeguarding important service lines against high maintenance costs. The installations represent only a fraction of more than 419 tons of corrosion-resistant wrought iron piping used throughout the modern terminal. Approximately 317 tons of this pipe, size one inch to eight inches, is specified in a single application—to protect vital underground gasoline fuel lines against damage from corrosion. Identical protection is provided by 102 tons of wrought iron pipe employed in hot and cold water lines, downspouts, steam supply and return piping, gas lines, condenser water and chilled water systems.

HIGH VOLTAGE SWITCHES

▲ The completion of the first order for 330 kv switches ever to be placed in the United States has recently been announced by Delta-Star Electric division, H. K. Porter Co.

These ultra-high voltage switches are now being installed on the transmission lines supplying the huge Atomic Energy Commission project



near Portsmouth, Ohio. Rated at 1600 amperes, these switches are the highest voltage switches ever built in this country. Delta-Star is supplying the major portion of such units to be installed on this project.

HYDRAULIC PRESS

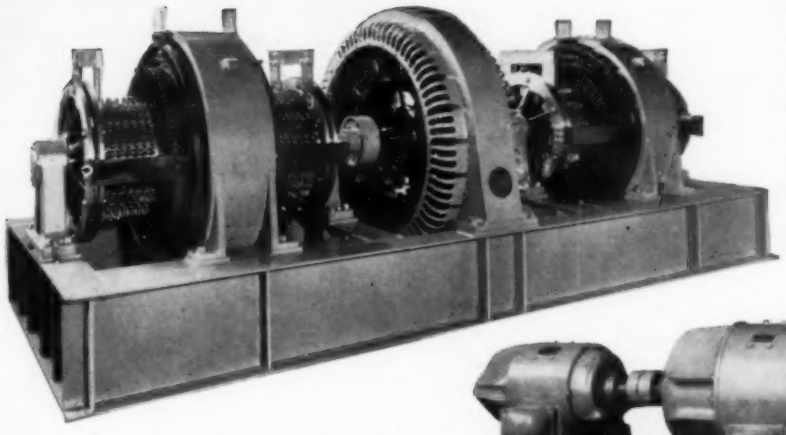
▲ A massive hydraulic press is a Lake Erie Engineering Corp. unit of 4500 tons capacity used to head steel shell cases of 6 in./47 and 155 mm. This press is one of a complete line installed at a United States ordnance plant.

Equipped with a hydraulic shuttle, press loading operations may be accomplished with facility from either the front or the rear of the press. The

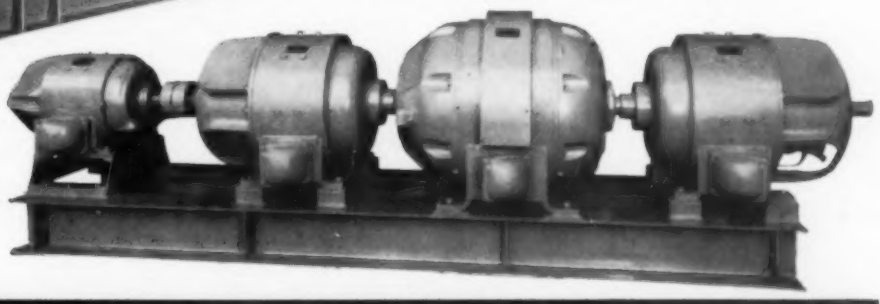
COLUMBIA

MOTOR GENERATORS

Whether it be for continuous electrolytic tin-plating or electrocleaning lines, or for special power needs, Columbia builds Motor Generator Sets for your individual requirements. They're giving superior, around-the-clock performance in many of the country's leading mills. Illustrated here are typical installations of Columbia generators built to specification.



Two 7500 Ampere 24 volt, 3750 Ampere 48 volt, Separately Excited, Columbia D.C. Generators driven by 600 HP, 1.OPF, 360 RPM Synchronous Motor.



Multi-Unit Columbia Motor Generator Set consisting of two 50 KW, 250 Volt D. C. Generators, and one 10 KW, 50 Volt, 200 Ampere booster Generator, all driven by 200 HP, 0.8PF, 1200 RPM Synchronous Motor.

COLUMBIA ELECTRIC MFG. COMPANY

4543 Hamilton Avenue Cleveland 14, Ohio

TOPS FOR PRODUCTION OF HIGH GRADE STAINLESS, ALLOY AND RIMMING STEELS

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ELECTRIC MELTING FURNACES

EMBODYING the latest in mechanical and electrical equipment, these widely used furnaces are noted for their efficient performance and safety, and low operating cost and maintenance.

We welcome an opportunity to help you select and install the furnace best suited to your particular requirements.

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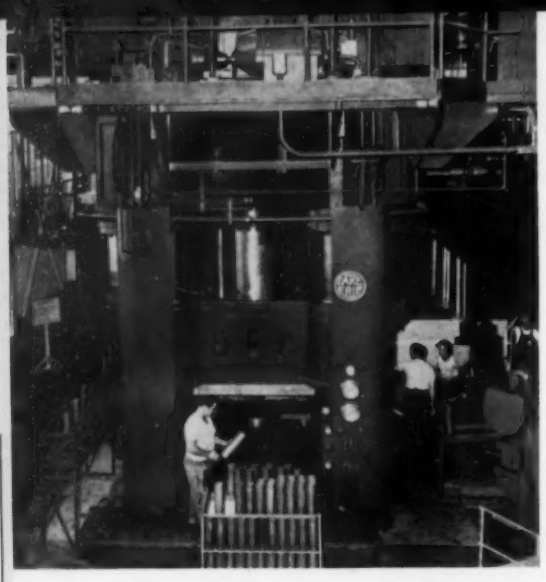
GENERAL OFFICES: 525 WILLIAM PENN PLACE, PITTSBURGH, PA.

Contracting Offices in New York, Philadelphia, Chicago, San Francisco and other principal cities.
United States Steel Export Company, New York

Removable roof of new design now available for large furnaces.

USS

UNITED STATES STEEL



bed dimensions measure 66 in. x 54 in., the pressing stroke is 36 in. and the daylight opening is 126½ in.

The press has a closing speed of 350 in. per min and a similar return speed. Pressing speed is 14 in. per min to capacity. A choice of single or dual heading operations during the semi-automatic cycle can be selected by the operator.

CALIBRATED ROPE

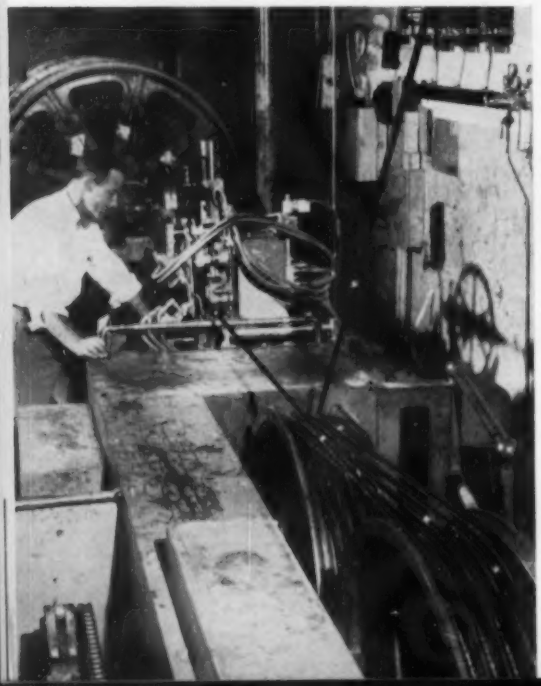
▲ Development of a new accurately calibrated wire rope which makes "at-a-glance" length measurement possible for the first time was announced by Paulsen-Webber Cordage Corp.

The new rope is marked in accurate colored bands at five-ft intervals, as standard practice, but may be marked in feet or fathoms at any desired intervals for ready measurement. Prior to this development wire rope could only be measured by special warehouse measuring equipment or by unreeling it and measuring wanted lengths by hand, on the ground or floor, exposing the desired length of rope to dirt and causing delays, possible abrasion damage, and inefficiency in handling.

Perfected after extensive research and study of special marking pigments and techniques, the marking is now being applied on a mass production basis to two top grades of wire rope, improved plow steel, and standard plow wire rope. The rope is marked in 20 dimensions of these grades ranging from ⅛ in. to 1½ in. diameters.

Until now, users of wire rope have had to make their own measurements before cutting rope to lengths. This costly awkward and time-consuming process is now eliminated, saving substantial man hours of labor and hundreds of thousands of dollars in needless operating costs in the industries using wire rope, by helping workers clean up the wire-handling job.

Automatic marking machine makes possible for the first time an efficient method of measuring wire rope. This unit accurately marks 5-foot lengths with a band of gold.



CONDUCTIVITY METER

▲ Introduction of the "Magnatest FM-100" conductivity meter has, by permitting rapid measurement, made the physical property of conductivity a practical and useful industrial tool. Magnaflux Corp. has combined its experience in modestructive testing and electronics to bring out this instrument and thereby make conductivity measurements quickly available for laboratory control or factory use. The need for wire-like samples or cross-sectioning of parts eliminated. The meter gives absolute conductivity measurements of non-ferrous conducting materials directly from a large dial on the front of the unit. An operator merely places the simple hand probe on a part and reads the dial. All that is required is a relatively flat area about ⅜ in. in diameter on which to place the probe.

Because it is easy to operate, the meter has many uses. For many applications the absolute conductivity reading is all that is needed. In some cases, these readings can be used to sort mixed lots of metals and alloys.

The other general category of applications depends upon the relationship between conductivity and other physical properties. The conductivity of aged aluminum alloys, for example, varies with temper. Therefore, once standard comparisons are made in the laboratory, the destructive indent hardness test can, in many cases, be replaced by the nondestructive instrument. The meter can also be used for process and quality control in heat treatment. Again standard comparisons must be made. Still another application is controlling the purity of melt of non-ferrous metals and alloys. Small samples can be drawn, quenched, and rapidly tested.

IMMERSION UNIT

▲ Field reports from a half-dozen steel mills using a new molten steel temperature-measuring unit developed by Minneapolis-Honeywell's industrial division indicate 50 per cent faster readings and up to 1,000 per cent extension of the life of immersion thermocouples, the company announced recently.

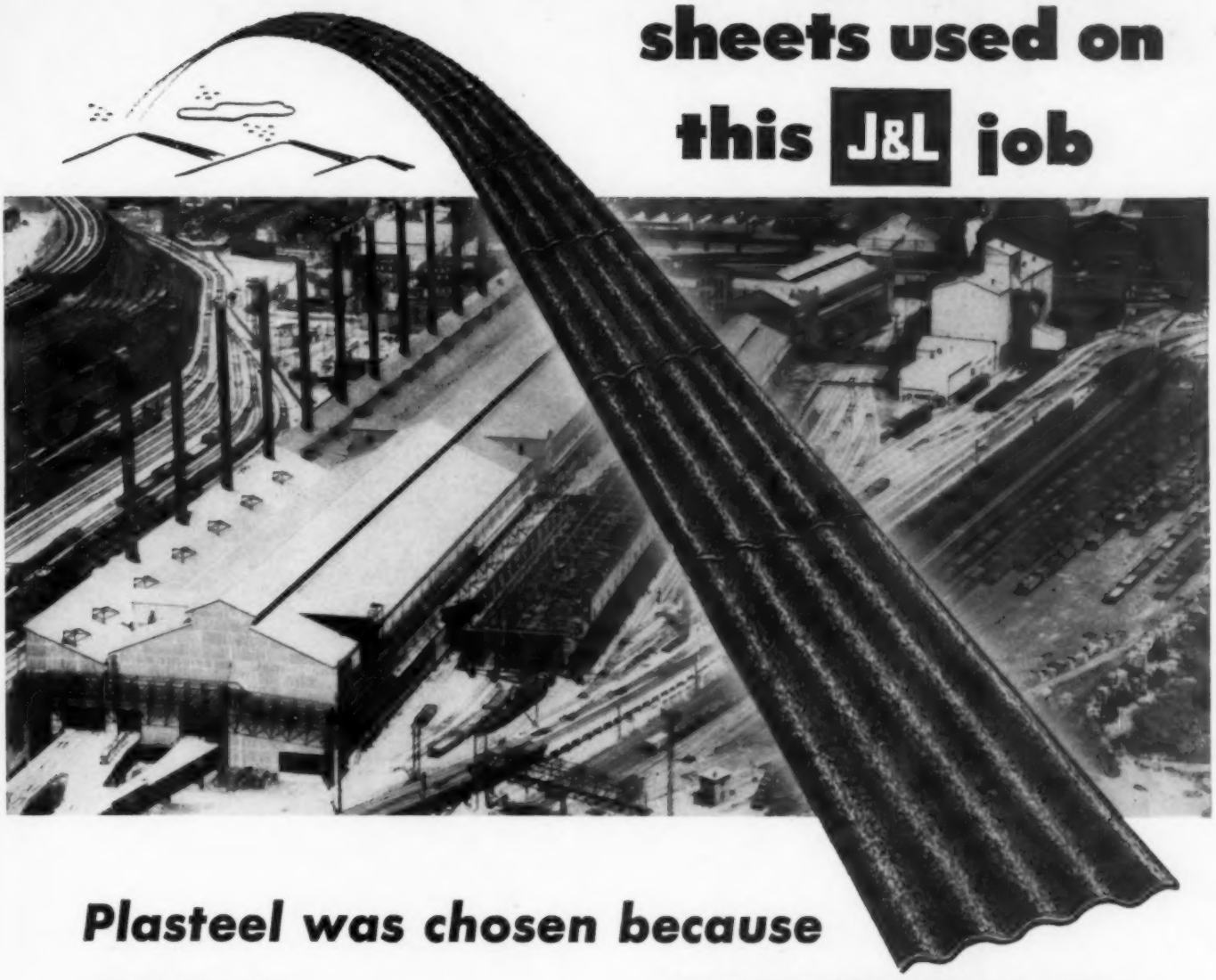
The new unit comprises a molten steel recorder and an instrument called a "balance detector," an electronic detecting device.

The company's steel industry engineers explain that immersion time via conventional methods usually runs from 20 to 22 seconds. Even then, they explain, the information is not always reliable because there is no assurance that true temperature has been indicated. Utilization of the "balance detector" speeds up reading time to 10 to 15 seconds. In addition, the new unit signals the operator at the precise moment the maximum, or true reading is obtained. This guards against the outright disintegration of the expensive platinum thermocouple, which occurs if the operator misjudges immersion time by as little as three seconds.

In one mill, the company reported,

(*Please turn to page 202*)

40 miles of Plasteel sheets used on this J&L job



Plasteel was chosen because

MICA makes the DIFFERENCE

40 miles of *Plasteel* sheets—33" wide is a lot of roofing and siding. That, to the plant engineer, is 635,000 square feet of maintenance-free building protection. Only *Plasteel* gives you the advantages of Mica . . . and Mica makes a big difference! The Mica topping reflects the sun's rays and prevents the drying out of the volatile oils in *Plasteel's* asphalt-plastic coating. Mica prevents deterioration and practically eliminates maintenance costs. It provides a tough wearing surface, and gives *Plasteel* a pleasing finish. That's why more industrial building projects specify *Plasteel* today.

If you are planning new buildings, mail PLASTEEL Coupon today.*

PLASTEEL PRODUCTS CORPORATION

WASHINGTON, PENNSYLVANIA

ISE-8-53

* *Tested and classified by the Underwriters' Laboratories and Associated Mutual Laboratories.*

PLASTEEL PRODUCTS CORPORATION
WASHINGTON, PENNSYLVANIA

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☐ Sample of *Plasteel*

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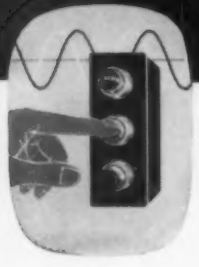


AUTOMATION STARTS WITH WESTINGHOUSE MOTORS AND CONTROLS

How Westinghouse Motors and Controls answer the need for dependable auxiliaries in a blooming mill...

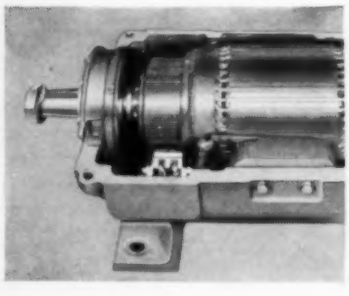
Greater speed, precision and stamina are typical advances made in modern steel plant operations through automatic, integrated control and skillfully engineered motors.

There's the record set in reversing the blooming mill at the Jones & Laughlin Steel Corporation. Here is an example of the performance of Westinghouse Main Drive Equipment backed up by the performance of Westinghouse Motors and Controls applied to the auxiliary drives.

The low-inertia armature of the Westinghouse Type MC Mill Motor for auxiliary drives allows starting, stopping and reversing under heavy loads in minimum time. As a result, low current peaks and energy consumption are assured. Better commutation, heavier axle steel shaft and higher maximum safe speeds are but a few of the many other advantages from applying Westinghouse Mill Motors.

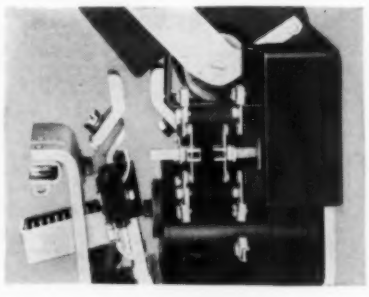
Controls for auxiliary drives have been designed to give the maximum protection with high-speed operation. The best in control devices is used. For example, with Westinghouse Type M Contactors at work in your mill, you're assured of millions of trouble-free make-breaks even on the toughest jobs. Knife-edge bearings on Type M Contactors eliminate friction . . . reduce wear. A strong kickout spring delivers faster action for rapid, cyclic operations. Special arc chambers snuff out harmful arcs, thereby increasing contact life. Interlocks, mounted directly on the contactor frame, enable you to get any precise sequencing required.

Investigate Westinghouse Mill Motors and Controls. Ask your local Westinghouse salesman for booklet B-5650, *Westinghouse Mill Motors and Control Equipment,* or write to: Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-21786



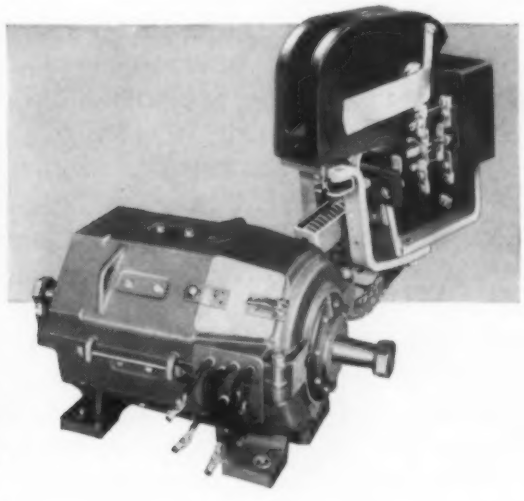
Heavy-duty Armature

Core is accurately bored and pressed on axle steel shaft eliminating quill. Coils are held in slots with wedges, rather than conventional bands, permitting safer operation.

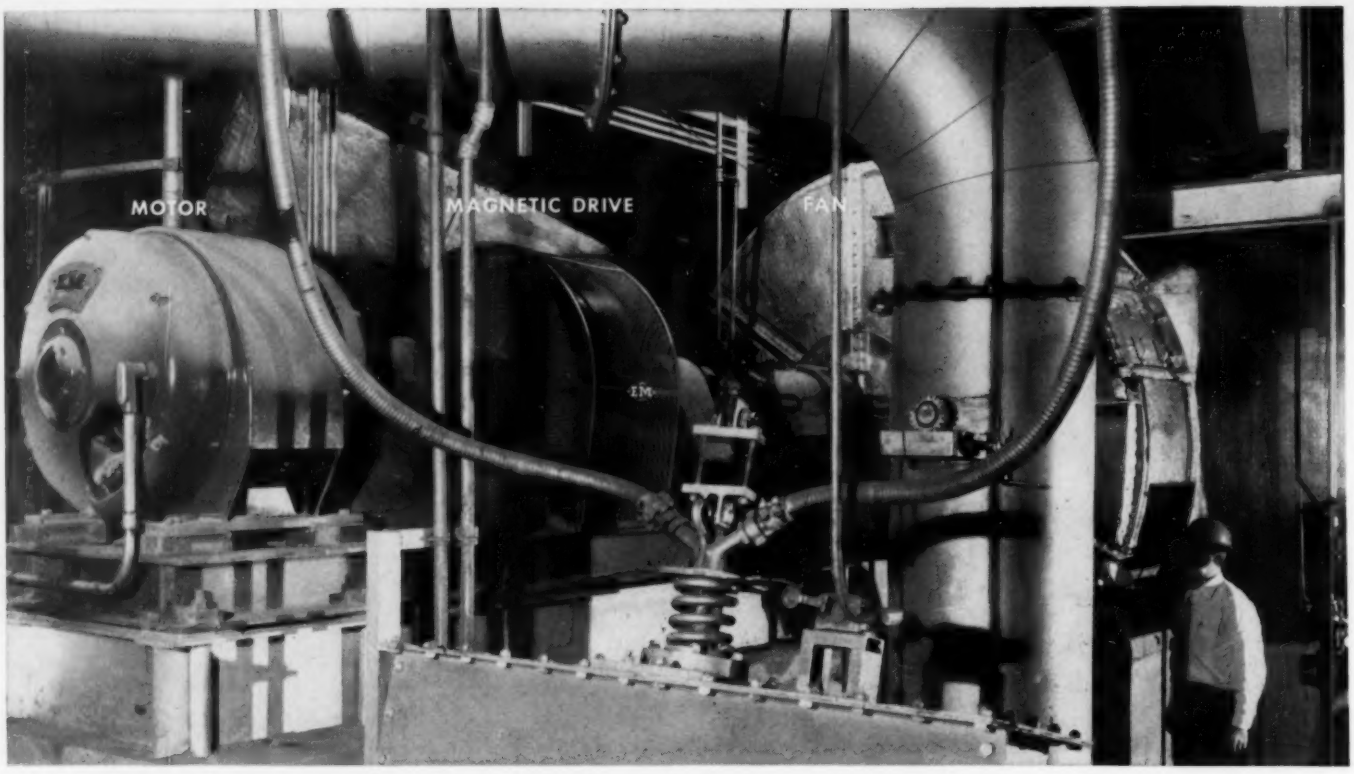


Unit-mounted Interlocks

Electrical interlocks are mounted directly on the contactor frame and maintain correct alignment with the moving armature. No troublesome operating linkages are required.



YOU CAN BE SURE...IF IT'S Westinghouse



A waste-heat boiler induced draft fan in a large steel mill receives driving power and precise speed control from a 200 hp, 720 rpm E-M Synchronous Motor and a 200 hp, 350/705 rpm EM Adjustable-Speed Magnetic Drive.

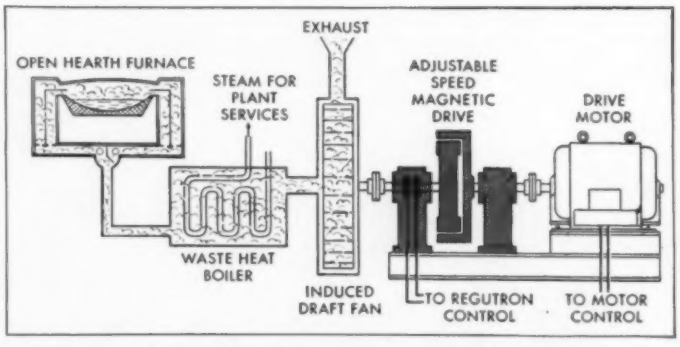
How to reduce erosion of waste-heat boiler induced draft fans

Many modern steel plants now use waste heat from banks of open hearth furnaces to produce steam for plant services. An induced draft fan draws waste gas through a waste-heat boiler to recover heat from open-hearth gases usually exhausted out a stack.

Speed control of this fan is essential for economical operation, and the E-M Adjustable-Speed Magnetic Drive is the best answer to this need. It transmits torque electromagnetically from the constant speed drive motor to the fan, responding automatically and precisely when speed changes are signalled. This Drive, with the sensitive E-M Regutron Control, provides *true* speed control regardless of variations in operating conditions.

Sizable reductions in fan blade erosion are achieved, as the fan is not required to run constantly at full speed against the highly abrasive gases when reduced output is wanted. The Magnetic Drive is equally effective and economical in drawing cool air through the boilers during shut-down for boiler maintenance or repair.

See how this Drive can save costs and increase over-all efficiency in your plant. Ask your nearest E-M sales engineer for details, and write for E-M Publication No. 1107 on Magnetic Drives.



Here, in a simplified diagram, is how the E-M Adjustable-Speed Magnetic Drive fits into the Waste-Heat Boiler system, providing precise, automatic control of the induced draft fan.

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EXACTLY WHAT YOU WANT THEM TO

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That's the experience of a midwest steel mill who tell us: "We have in service GRID Unit Heaters Type No. 2500. A number have been in use for approximately 22 years on very severe service with steam turned on and off rapidly several times each day. Even under this severe service we have found them maintenance-free." There's the word of a mill operator who has proved that, with a GRID installation, first cost is last cost. Such service records (GRID installations made in 1929 are still operating) are the rule rather than the exception with GRID Unit Heaters because . . .

GRID is an all cast unit with finned heating sections and headers tested to withstand steam pressures up to 250# P.S.I.

GRID construction uses no brazed, soldered, rolled or welded connections between condenser and headers. A specially designed threaded nipple assures a precision, leak-proof fit.

GRID construction has all similar metals in contact with steam, thus preventing electrolytic corrosion which eventually occurs in copper type unit heaters where steam passes from iron pipes into copper cores. (Write for booklet CORROSION IN UNIT HEATERS.)

GRID construction resists corrosion from fumes present in most types of industry.

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Eastern Stainless Steel Corp. uses GRID BLAST COILS for sheet drying. Write for Catalog BC-1049.

These are the reasons why steel mill operators get 22 years and more of trouble-free service. There are units cheaper than GRID, but there is none better. You start saving money the day you install GRID UNIT HEATERS. Get the complete GRID story. Write for catalog CUH-846-A.

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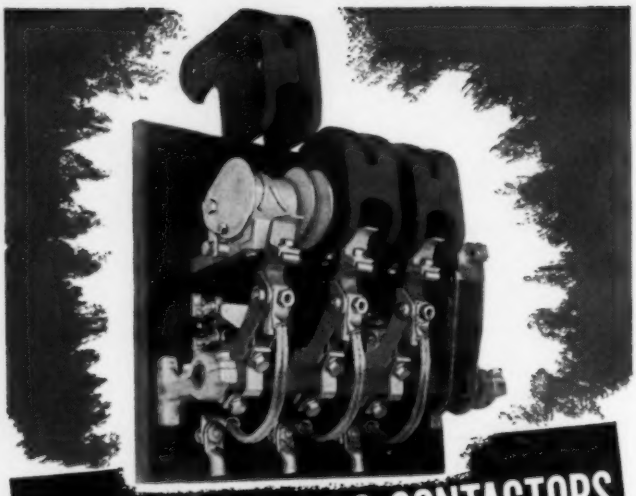

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7	Standard electrical interlock has n.o. and n.c. contacts - electrically separate	✔	
8	Stainless-steel springs on both main and auxiliary contacts.	✔	
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Make these ten, top-priority features the guideposts in selecting A-C Contactors. You'll find Euclid Electric Contactors thrive on comparison because *only* Euclid offers all ten. *Plus* sound design, *plus* precision workmanship, *plus* 30 years of experience that make E.E. the leader in motor-control apparatus.

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The need for blood is greater than ever, not only for men wounded in combat, but here at home . . . to cure disease, to meet accidents and disasters, and to prepare for civil defense.

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Remember . . . once is NOT enough. Give blood again and again! Call your Red Cross, Armed Forces or Community Blood Donor Center for an appointment to give blood today.

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...give it again and again

BUSINESS EXECUTIVES!

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If you can answer "yes" to most of them, you—and your company—are doing a needed job for the National Blood Program.

- ◯ HAVE YOU GIVEN YOUR EMPLOYEES TIME OFF TO MAKE BLOOD DONATIONS?
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- ◯ DO YOU HAVE A BLOOD DONOR HONOR ROLL IN YOUR COMPANY?
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- ◯ WAS THIS INFORMATION GIVEN THROUGH PLAN BULLETIN OR HOUSE MAGAZINE?
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Remember, as long as a **single** pint of blood may mean the difference between life and death for **any** American . . . the need for blood is **urgent!**

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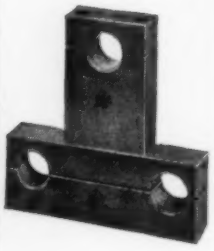

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USE THE ENGINEERING MART

EQUIPMENT NEWS

(*Continued from page 192*)

the cost for each temperature reading by conventional means was five dollars. Through use of the new unit it was reduced to eight cents per immersion.

Book Reviews . . .

▲ "ASTM Manual On Measurement And Sampling Of Petroleum And Petroleum Products," second edition, presents the latest and most practical measurement practices that are widely used today. Actually, the manual comprises seven ASTM Standards but with considerable additional explanatory and descriptive material. The book provides recognized methods of measuring and computing oil in storage tanks of various types and for getting typical samples. Copies of the 150-page manual, in heavy paper cover, can be obtained from headquarters of the American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pa., at $1.50 each.

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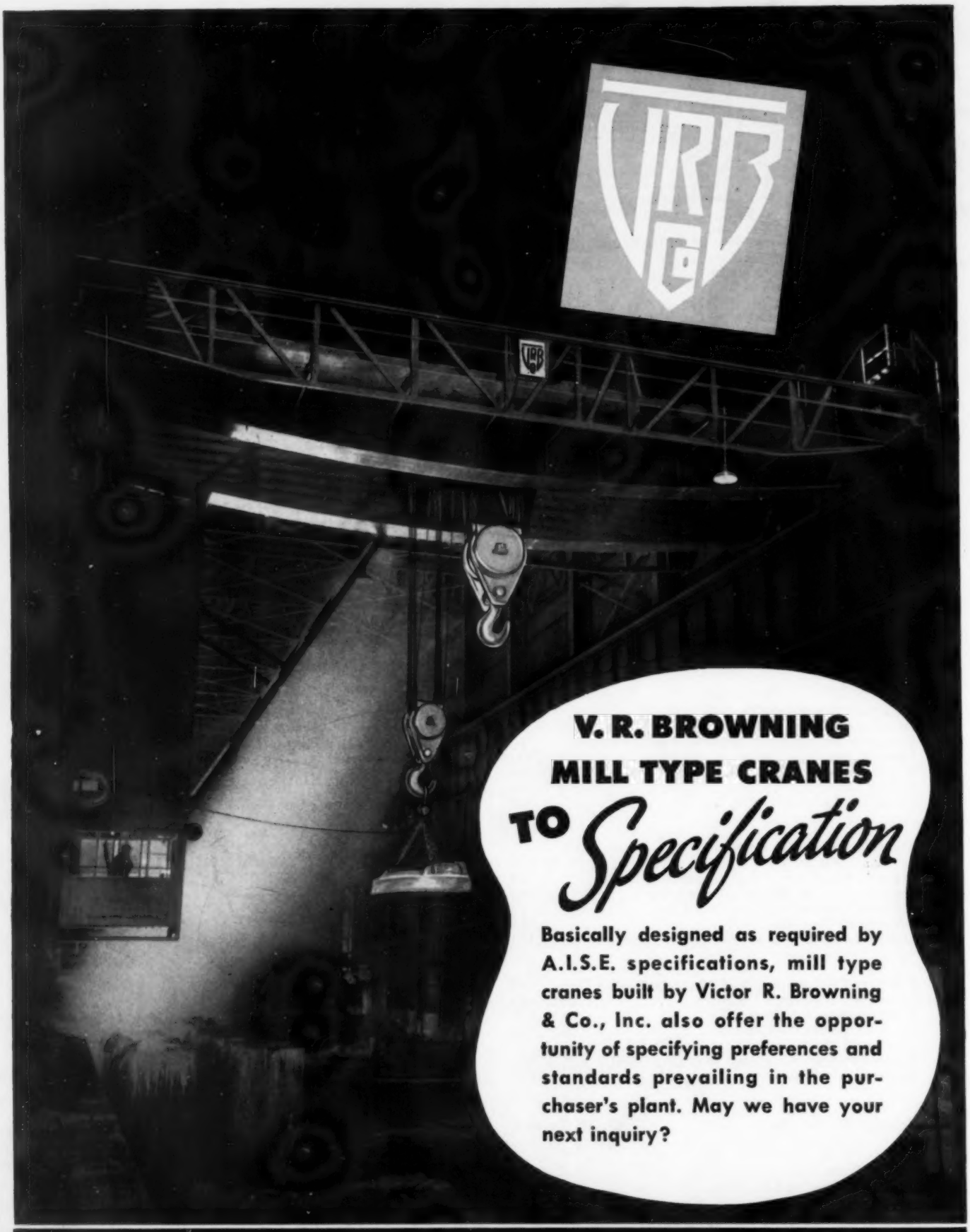
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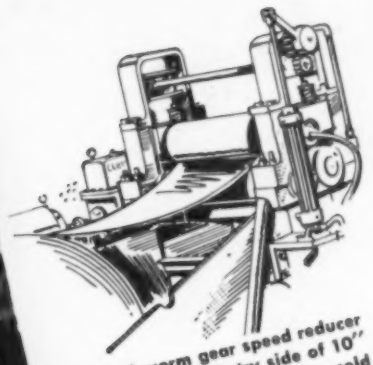

Cleveland worm gear speed reducer drives coil box on entry side of 10" & 26" x 28" 4-high reversing cold mill and Cleveland worm gearing operates screwdowns. Illustration by courtesy of the Lewis Machinery Division of Blaw-Knox Co.

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